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JUN 16 1923

ENGINEERING & MINING JOURNAL-PRESS

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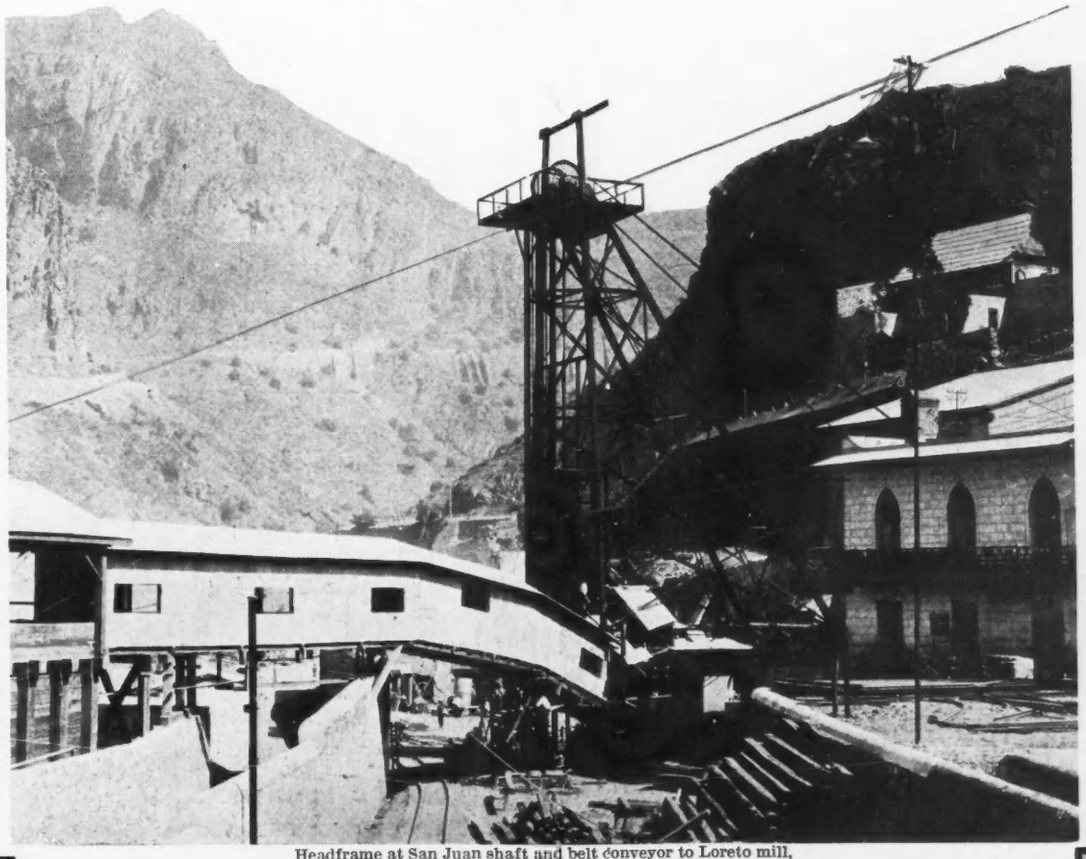

Headframe at San Juan shaft and belt conveyor to Loreto mill, Cia de Real del Monte y Pachuca, Pachuca, Hidalgo, Mexico

A WEEKLY JOURNAL REPRESENTING THE WORLD'S MINING AND METAL INDUSTRIES

June 16, 1923

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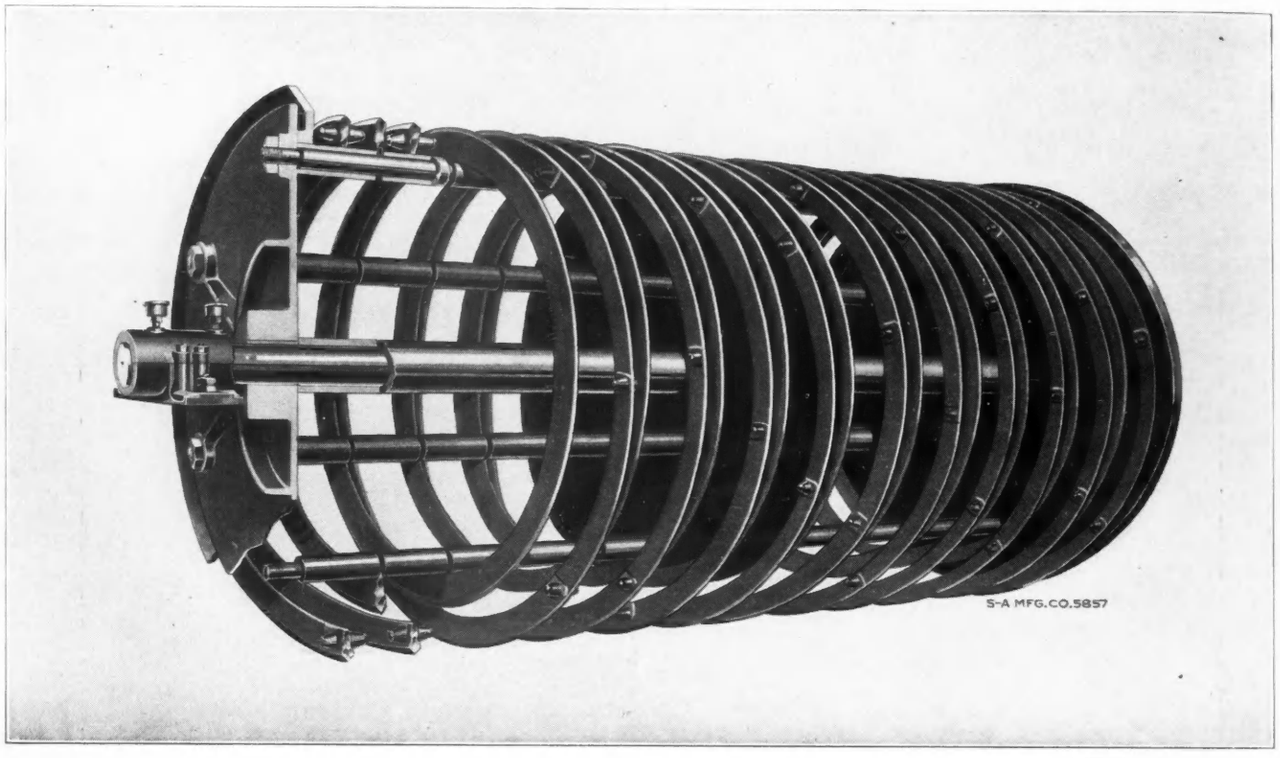
A new non-clogging grizzly—



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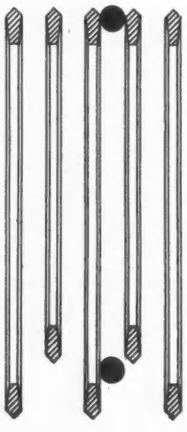


Where fines are to be separated from the product that goes to the crusher, the Burch Grizzly is right in its element. The Grizzly will carry over the lumps to the crusher and allow the fines to be by-passed.

This Grizzly was invented by H. Kenyon Burch, prominent Mining Engineer.

Built in three standard diameters, 36, 48 and 60 inches and in any width up to 10 feet. The ring spacing can be constructed to suit the requirements.

The over-size is carried over on top the rings. The fines pass thru.

STEPHENS-ADAMSON MFG. CO., AURORA, ILLINOIS

ENGINEERING & MINING
JOURNAL-PRESS
JOSIAH EDWARD SPURR, Editor

Volume 115 New York, June 16, 1923 *Number* 24

The Last of Dollar Silver

AS ALL FOLLOWERS of the silver market know, the purchases of silver under the provisions of the Pittman Act ceased at the end of May, and producers who have had the benefit of a high and stabilized price for over three years must now take their chances in the world market. We do not think that we are taking a narrow view of the matter when we express the belief that the Pittman Act has been one of the most, if not the most, beneficent of the wartime legislative acts involving industry. The silver was released at a precarious time in the affairs of the world, and if it had not been forthcoming there would have been much more unrest, and possibly revolution, in India. The British Government obtained this silver from a non-commercial stock: the U. S. Treasury.

The release of silver under the terms of the Pittman Act prevented the silver producers of the United States from receiving the extremely high prices for their product which would otherwise have ruled. Their profits were curtailed, but this was no doubt a good thing, for excessively high peak prices are not, in the long run, good for an industry. As the price was stabilized on its upward swing, so it likewise was stabilized at $1 per ounce on the downward swing, so far as domestic producers are concerned. The United States Government and the people neither gained nor lost anything; the silver producers lost possible profits when they were prosperous, but had satisfactory prices when other metals were cheap, at no cost to any one.

Foreign producers of silver have also benefited indirectly by the Pittman Act, for if the United States production of silver had been thrown on the market for the last three years, the world price of silver would have been much lower than it has been. Now the market seems better able to absorb it; the reaction so far has been slight, and well-informed people look for no pronounced decline as the American production comes into the market.

It is a mistake to think that the end of the Pittman Act means the end of silver mining in the United States for the time being. There are scarcely any mines in the country which produce silver exclusively. At most of the mines the metal is associated with gold, lead, or copper. Lead is selling at so satisfactory a price that most silver-lead producers will find no trouble in making money with silver at 65c. Gold, of course, is as valuable as ever. With the silver-copper producers, the price of silver is in most instances a minor factor, though the total amount of silver produced from such ores is large. Worthy of note, also, is the fact that silver producers have acquired a momentum during the last three years that will benefit them now. Many of them have been able to develop their mines and install proper equipment, so that now they can make money on 65c. silver, which would not have been possible had they had three years of adversity.

M. I. T.'s New President

MASSACHUSETTS Institute of Technology now has a new president, after having been without an executive head since January, 1920, when Dr. MacLaurin died. On Monday last, Samuel Wesley Stratton was installed in his new office with befitting ceremony. The appointment is a happy one. The man is suited to the institution. The great ability displayed by Dr. Stratton in conducting the affairs of the Bureau of Standards at Washington over a period of twenty-one years will now be directed to the greater task of holding "Tech" true to its traditions and its fame, however the scope of its work may widen and the demands made upon it may increase. He has a reputation for ability to direct research on a large number of diversified technical problems without losing sight of the objectives, and while so doing to get the best results. Ample opportunity for his talents will be afforded by his new employment.

Dr. Stratton leaves behind him in Washington, as a monument, the Bureau which he built up from modest beginnings to a point where it is a scientific laboratory requiring an appropriation of over $2,000,000 a year. The government loses an able official, which loss it is bound to feel, even though in Dr. George K. Burgess, the Bureau's new director, it has one who is well fitted to carry on the work.

Endangering Our Foreign Trade

TEN YEARS AGO American business cut a sorry figure in the export field. Honors were divided among the Germans, the British, and the French, with the Germans advancing in tremendous strides to a position of world domination. American manufacturers were noted chiefly by their absence. Activities credited to them were more often than not characterized by ignorance or indifference in matters of packing, credit relations, foreign languages and customs. Then came the war, with a readjustment of international trade relations. After some delay America began to figure in markets formerly supplied from abroad. Enthusiasm for export trade increased, especially as domestic demand slackened; studying its various phases for a time almost became a popular fad, and in the last few years the long slow process of building up goodwill abroad has been increasingly applied, or so it has been imagined.

But the truth is otherwise, according to Julius Klein, director of the Bureau of Foreign and Domestic Commerce. Mr. Klein charges that the allurements of domestic boom conditions have caused many of our manufacturers to become apathetic to legitimate requests and orders of foreign contacts; that the sound policy of definite allotments for export is being ignored in far too many cases. Among the faults cited is the failure of home offices to abide by prices at which representatives take orders. Only a few such experiences are needed to

sour the foreign customer and cause him to look elsewhere for what he needs. Thus important markets may be lost. Thus, also, national prejudices may be formed, affecting the innocent as well as those who are guilty.

This is unfortunate, for the time is coming when we will need this foreign business to keep our mills and factories running profitably. Metal producers can hardly be included in Mr. Klein's indictment, for metal is sold for export in quite a different manner from that in which manufactured products are disposed of. Nevertheless, in the metal industry we have a good example of the importance of foreign demand upon operating conditions at home.

Manifestly, the maintenance of a good export demand for merchandise in general will tend to alleviate the depressions to which industry is periodically subjected in the course of the business cycle, as well as to make business even better in boom times. This will be possible, however, only by maintaining permanent outlets abroad for American products, and this, in turn, depends on the creation and preservation of goodwill. For this, courtesy and a readiness to serve are prerequisites.

The Wealthy Osage

POSSESSION of a Cadillac sedan usually indicates a state of at least mild affluence. It suggests the Ritz, the opera, the boulevard, the respectful traffic officer, and other things in keeping. Down in Oklahoma it still suggests affluence, but to many it has doubtless come to seem but the almost universal flivver of the Osage Nation. When the Cadillac is out of order, the Osage is reputed to use a taxi by the day until it is repaired. For he is a man of wealth, thanks to the discovery of oil and gas on his tribal lands. Really, it is disgraceful how these Indians have been maltreated. In 1922 alone this tribe of 2,229 individuals received a paltry $26,079,300 from their bonuses and royalties, giving each man, woman, and child $11,700. Royalties have aggregated $1,000,000 a month since 1915, all of which has been paid to the Secretary of the Interior, and distributed to the tribe, who are, in effect, wards of the government. For the eighteen years that have elapsed since oil was first discovered, the income totals over $136,000,000 up to May 1, 1923. Receipts from bonuses and royalties in April were over $6,000,000, indicating the present trend. It is said that not so long ago a cheaper car was favored by the Indians; as revenues increased, the Cadillac stage was reached, and now, perhaps, the tribe is on the verge of entering a Rolls-Royce period.

Up to March of this year the Osage lands have yielded 212,000,000 bbl. of petroleum, to say nothing of gas. In all, 8,360 wells have been drilled and 3,300 leases granted, each covering 160 acres, according to figures issued by the Secretary of the Interior. Up to the present, 550,000 acres of the Osage reservation's 1,500,000 acres have been found to contain petroleum.

Terms of the leases are strictly enforced by the government, and rigid regulations, which the operators have endorsed, have been drawn up. Thanks to this supervision the Burbank field has been drilled with a mathematical regularity, affording the visitor a remarkable sight, in contrast with other fields, such as the Tonkawa, where the location of holes is left largely to the operators to decide. This story of the Osage people is one of the most remarkable in American chronicles.

Boys and Bauxite

EVERY THURSDAY EVENING at 7:30 o'clock Mr. John T. Fuller, general superintendent for the American Bauxite Co. at Bauxite, Ark., has a very important engagement. Other important appointments he may break if occasion arises, but this Thursday evening engagement is always kept if Mr. Fuller is at Bauxite and not sick-a-bed. If he is away, his principal assistant takes his place. Mr. Fuller has a commodious and unusually comfortable bungalow at Bauxite, where he entertains frequent visitors. If any of these visitors—even, we imagine, the president of the parent company, the Aluminum Company of America—than whom no one looms more important in Bauxite—happens to be there on Thursday, he can take his choice of luxuriating alone at the bungalow or accompanying Mr. Fuller to the office. If he is fortunate he will choose the latter, for by so doing he will see the results of as interesting an experiment in psychology and sociology as one could wish.

Suppose the visitor elects to go. Promptly at 7:30 Mr. Fuller takes his place in a plainly furnished conference room that adjoins his own office and remarks genially to the town manager, who helps conduct the ceremony that is to follow, "Well, Tom, better let them in." The visitor probably wonders who "they" are. As answer in file twenty-odd boys ranging in age from eight to sixteen years; they have twenty-odd tolerably combed heads of hair and as many average-clean faces. They are dressed plainly but with reasonable neatness, and they are clearly engaged in very serious business, although currents of mischief can be seen surging around not far below the surface. Mr. Fuller is well over six feet tall, weighs considerably more than 200 lb., and can adorn his pleasant countenance with severity if need be, so that the proceedings are both dignified and at the same time informal enough to be human. The roll is called. Each boy answers to his name by arising, walking to the center of the room, saluting in military fashion and making his report by reference to a note book supplied to him for the purpose. He displays his badge, a shiny nickel-plated disk bearing the inscription "American Bauxite Company Boy Police," and gets a silver 50c. piece, his wages for the week. A perquisite that is probably regarded more highly than the wage is free admission at all times to the Bauxite moving picture palace. A boy who is absent is fined his week's pay; failure to bring his badge to the meeting costs him 25c. After the reports a brief general discussion follows; Mr. Fuller makes a short talk and the boys are dismissed. The whole thing smacks of efficiency and co-operation, and is suggestive of good citizenship.

As in so many other mining settlements, the population of Bauxite consists entirely of employees of the company, and the general superintendent is responsible for the welfare of the community. Bauxite is a town of several thousand, and the proportion of family men is large. Naturally, there are lots of boys, and boys are naturally prone to "raise Ned." Mr. Fuller conceived the scheme of establishing the Boy Police to combat a growing lawlessness among these embryo citizens. He had the town manager, the superintendent of schools, and the preachers make him lists of the "bad" boys. He selected the names that appeared on all the lists so as to be sure to get the worst and called a meeting of the boys. He gave them a fatherly talk, and then he broached his plan of

establishing the police. It has worked wonderfully. In emergency the boy policemen report to the chief of the regular police. They are leaders among the other boys, and accordingly have much influence with them. They are not authorized to use force in the execution of their duties. Their weekly reports to Mr. Fuller recite irregularities that have not demanded immediate attention. Here are a few of the many matters to which the boys attend:

They prevent blocking of culverts; unauthorized cutting of trees; damage to vacant houses and fences; and wasting of water. They report leaky water pipes; bad places in roads; and accumulations of pools of water where malarial mosquitos can breed. They gather up tin cans in which rain may collect for the comfort of other mosquitos. They keep boys from riding and risking their bones on the trains that carry bauxite from the mines. They have given information on which bootleggers were apprehended. That the plan pleases the boys is indicated by the fact that there are fifty applications on file for places on the force.

As to Mr. Fuller, he has every reason to be gratified. The plan promotes better conditions around the mines and the town; it results in a better community spirit, and in better morale among the workers. It thus saves money for the mining company. That is good mine management. Aside from all this, he no doubt cherishes the personal satisfaction that he is helping twenty boys to grow up into more useful men.

Other Curb Brokers in Difficulty

THREE New York Curb brokerage houses have gone into the hands of a receiver — including one that is said to have been the largest and most powerful of all—one that did 35 to 40 per cent of all the business that was transacted on this exchange. Fortunately, the crash does not seem to be such a bad one as those of a year or two ago in which the Ruskay firm and other members of the Consolidated Stock Exchange were involved; there seems to be a good chance that those who intrusted their money and securities to Jones & Baker will, in time, be paid back approximately in full. But they will have many moments of anxiety and will lose the use of their money and securities while the investigation is being made.

Mining men are particularly interested in the New York Curb market, for it is here that most of the trading is carried on in the stocks of the generally less important mining and oil companies. The stocks of many of the most reputable companies are listed on the Curb, but they are usually companies whose stocks have a par value of $1 instead of $100. Small traders would rather have a hundred shares of a $1 stock than one share of a $100 stock, though the equity is the same in either case.

The reputation of some members of the New York Curb among conservative financial men is none too good. We once inquired of a man well acquainted with the affairs of Wall Street for the name of a Curb broker of established reputation, who never did any so-called bucketing, and who was honest and above reproach in every way. He replied "There ain't no such animal." Possibly this is taking a somewhat too pessimistic view of the situation, but the fact remains that unsound practices are all too common.

The question naturally arises as to what a small investor or speculator should do if he wants to buy a security traded in on the Curb, whether it is the stock of a resourceful mining company like the United Verde Extension, the New Jersey Zinc, or the Nipissing, or the stock of some prospect or small mine, examples of which we will forbear mentioning. We suggest two methods, either of which is better than entrusting money to some uncertain broker. Go to your local bank, talk the matter over with the manager, and get him to buy the stock for you through his established connections. Should there be any loss, the responsibility will then be his, and you will have the benefit of his advice. Or, if preferred, write direct to any of the old-established reputable members of the New York Stock Exchange. Failures are not unknown on this exchange, of course, but the likelihood of such a happening among the best companies is exceedingly small. They will gladly buy Curb securities as well as those dealt in on the big exchange, doing the business through their established agents, whose responsibility they have investigated. Here, again, the responsibility of a Curb failure is shifted off from the shoulders of the ultimate buyer. The disadvantage of buying through a bank or established Stock Exchange house is that they will not carry unseasoned stocks on margin; you must buy outright. But as this is the only way such stocks should be bought any way, except by professional traders, this restriction should really be classed as an advantage.

While we are on the subject, we wish to warn our readers against the information about mining companies contained in brokers' circulars. It is almost always misleading; only the bright side of the picture is given, and it is painted with red paint. Brokers of the highest grade do not issue market letters of the type we have in mind.

Metallurgical Efficiency

AN INTERESTING TECHNICAL ITEM is to be found in that section of the Phelps Dodge Corporation 1922 annual report that deals with the progress of the Moctezuma Copper Co., a subsidiary operating in northern Mexico. Interest has been evinced in many quarters as to the metallurgical efficiency of the plant at Nacozari, the flow sheet of which was modified and the mill redesigned by Mr. Kenyon Burch. From the report in question it appears that 295,004 tons was milled during the year, containing 3.089 per cent copper as sulphide and 0.089 per cent as oxide. The concentrates produced comprised 43,699 tons assaying 10.02 per cent, and 30,280 assaying 14.86 per cent. The tailing contained 0.135 per cent copper as sulphide, which shows an extraction by concentration equal to 96.7 per cent of the total sulphide-copper content of the ore. The metallurgical results, the report states, have fully met expectations.

From this statement it would appear that optimism was a feature of preliminary estimates. The mechanical troubles and difficulties attendant on starting up the mill, the report adds, were surprisingly few. This explains, in large part, the reason for the metallurgical efficiency. The applicability of a scheme of operation to a particular ore may be worked out to the limit of experimentation, human reasoning, and research; but the crux of the matter is the method of application. The mechanical practicability of a process is the determining factor; it is one that demands broad experience in design and operation, and a recognition of fundamental engineering principles.

Metallurgists will look forward to learning details of the work being done at the Nacozari concentrator.

DISCUSSION

"Engineering and Mining Journal-Press" is not responsible for statements or opinions published under "Discussion." In many cases the views expressed are diametrically opposed to editorial policy and belief.

Recording Claims With Land Office

THE EDITOR:

Sir—In connection with the discussion of the so-called "Arentz Bill," there has been much criticism offered of the requirements that mining claims should be recorded with the United States Land Office. As any United States Commissioner or county clerk can accept a filing for transmission to the Land Office of the district, this need not be the hardship that it has been supposed it would be, and it would afford protection to the miner in a direction in which protection is now lacking. Under present conditions the Land Office has no record of a claim until application to patent it is filed. An office may receive an application under a non-mineral law for a tract of land on which a mining claim may have been maintained for years. There is nothing on its records to show the existence of the mining claim, so it allows the non-mineral application. Then, notwithstanding the fact that his right may be years older, the mining claimant must bring an action against the other, and, furthermore, because he has no standing so far as the Land Office records show, he must assume the burden of proof in the trial of the case. If the mining claim were of record at the Land Office, any application for the same land would be rejected, or the non-mineral applicant would be required to start the action and assume the burden of proof in showing the illegality of the mining claim.

This one thing alone has been the cause of endless trouble, considerable bloodshed, and much expense on those who are least able to bear it.

Of course, to be of value a record must be sufficiently definite to identify the land positively on the plats. Such a description as that usually found, for example, "Commencing at a stake which is about five miles southerly from John Doe Mountain and running thence 900 ft. northeasterly and 600 ft. southwesterly," is of no value as a record. To answer the purpose the description should either be by legal subdivisions or by an actual metes and bounds survey tied to a government survey corner. Both of these requirements are open to objection on the ground of expense, as in the majority of cases a survey would be necessary to establish the legal subdivision on which a claim might be situated, and the claim owner would rather spend his money on his claim, at least until he knew he had one worth surveying.

I believe that it would be a wise provision to make recording at the Land Office optional with the claim owner. This would afford him protection against conflicts with applicants under the non-mineral land laws, and the objection as to expense could be met by crediting the cost of the survey to first year's assessment work.

San Francisco, Calif. LEROY A. PALMER.

The Mystery of A. O. S. M. Revealed

THE EDITOR:

Sir—In the *Engineering and Mining Journal-Press* issue of May 12, 1923, I was surprised to find in the editorial news a criticism of a small circular issued a short time ago. Considering the editorial rather than scientific character of the criticism, it is probable that, acting upon an opinion very generally received, the most noble reply would be silence, but this, although significant, might be by some readers misunderstood, and I therefore offer a few explanations.

Re "A. O. S. M. (whatever that may mean)"—my qualification for the right to use these initials was derived as follows:

1. Attending a school for the preparation of mine managers and battery superintendents for five years, passing with credit practically every subject upon the syllabus, winning various prizes and receiving, in competition, a government mining scholarship for three years at the Otago University School of Mines, New Zealand.

2. Attending the Otago University School of Mines for four years (the scholarship was extended one year), passing with credit every subject upon the syllabus and winning the school medal in petrography and mineralogy.

3. Serving in the various occupations of a miner in coal and metal mines, working in mills and upon geological surveys.

The "A. O. S. M. (whatever that may mean)," was the result of the above. That is all it was intended to convey and that is all I believe the public cares to know. Not wishing, however, to be outdone in politeness, I add the interpretation: "Associate of the Otago University School of Mines."

Regarding your criticism of various statements I made respecting examinations of ore deposits in volcanic regions, I was still further surprised, as I was not aware that these indicated anything very new in geology. The statements I made are simply the result of

1. About sixteen years' training and experience in ore deposits in volcanic regions.

2. A fairly complete knowledge of the researches carried on for the ten years preceding the year 1923. This does not mean textbook publications but the publications by scientific societies and institutions of the researches of eminent American and foreign scientists upon volcanics, and the active volcanoes of the world; laboratory researches upon differentiation, and a considerable opportunity upon my part to study the results of such researches in the field.

Regarding your statement of the surface limits of a propylitized zone being "a matter of mere observation open to most," I certainly differ, considering that such work requires at least a thorough knowledge of petrography, mineralogy, and inorganic chemistry.

Regarding the criticism of the three remaining statements, at the present time it must, I believe, be analyzed as but a personal opinion. I welcome, however, intel-

ligent scientific criticism, based upon scientific facts, believing, with Huxley, that the scientific aim should be "To follow truth with singleness and honesty of purpose." I would be glad to hear the reasons for your emphatic negative to my statements, but while the *Engineering and Mining Journal-Press* continues to publish such as the following, "This is one of the valuable points which our geological study has brought to light and should serve to eliminate prospecting in nonfavorable areas"—same issue, page 837—I do not feel it necessary to offer explanations. GEORGE E. HYDE.

Los Angeles.

Mechanical Sampling of Ore

THE EDITOR:

Sir—With reference to the article "Mechanical Sampling of Ore," by Messrs. Demond and Halferdahl, in the issue of Aug. 12, 1922, I think the following comment may be made:

They divide all ores to be sampled into two classes (p. 284)—base-metal ores, and precious-metal ores; but their subdivisions of these overlap, and no indication is given as to when these subdivisions are to be chosen.

A reference to previous work in this subject apparently shows that all the standards likely to be required in sampling have already been set by R. H. Richards. Of his work, C. H. White, in "Methods in Metallurgical Analysis," p. 9, says:

"In problems of sampling there are so many unknown quantities, and these are subject to such great variation, that a mathematical treatment of the subject does not yield results of a very practical character. The most reliable way to determine what size of sample should be taken from an unknown ore, is to sample a large lot of it in duplicate; . . . if the assays from the two samples are not concordant, within the limit of error in assaying, the whole lot is sampled in duplicate again. . . . In this or a similar way . . . the smallest lot that may be taken for a sample of each of various grades of ores has been determined in many mining districts. These results have been brought together and tabulated in convenient form by Prof. R. H. Richards (as follows):

Pounds to Be Taken in Sampling Ore	Very Low Grade or Very Uniform Ores (1)	Low-grade or Uniform Ores (2)	Medium Ores (3)	Medium Ores (4)	Rich or Spotted Ores (5)	Very Rich or Excessively Spotted Ores (6)
	Diameter of the largest particle in mm.					
20,000	207	114	76.2	50.8	31.6	5.4
10,000	147	80.3	53.9	35.9	22.4	3.8
5,000	104	56.8	38.1	25.4	15.8	2.7
2,000	65.6	35.9	24.1	16.1	10.0	1.7
1,000	46.4	25.4	17.0	11.4	7.1	1.2
500	32.8	18.0	12.0	8.0	5.0	0.85
200	20.7	11.4	7.6	5.1	3.2	0.54
100	14.7	8.0	5.4	3.6	2.2	0.38
50	10.4	5.7	3.8	2.5	1.6	0.27
20	6.6	3.6	2.4	1.6	1.0	0.17
10	4.6	2.5	1.7	1.1	0.71	0.12
5	3.3	1.8	1.2	0.80	0.50	....
2	2.1	1.1	0.76	0.51	0.32	....
1	1.5	0.80	0.54	0.36	0.22	....
0.5	1.0	0.57	0.38	0.25	0.16	....
90 grams	0.66	0.36	0.24	0.16	0.10	....
45 grams	0.46	0.25	0.17	0.11	.....	....
22.5 grams	0.33	0.18	0.12	.....	.....	....
9 grams	0.21	0.11	.....	.....	.....	....
4.5 grams	0.15	.....	.....	.....	.....	....
2.25 grams	0.10	.....	.....	.....	.....	....
Constants						
a =	2	2	2	2	2	2
k, when diam. is in inch,	303	1,000	2,220	5,000	12,800	441,000
is in mm.	0.47	1.55	3.46	7.75	19.9	686.

The last three lines show the constants I have found belonging to the weights for each class of ore. The weights put forward by Richards are most definitely bound together, for any class of ore, by an equation of the form suggested by Demond and Halferdahl,

$$W = k.\ d^a$$

where W = weight of sample in pounds,
d = diameter of particles,
a = constant,
k = a constant depending on the class of ore, and on whether d is stated in inches or millimeters.

It is fortunate that such a simple exponent for d is involved.

Therefore, unless these weights quoted by Richards are found to be erroneous, there is no need to do other than apply them as carefully as may be found to be necessary.

It may be possible to connect the numerical coefficient in the above formula with the ratio of values in the particles of highest and lowest value.

Queenstown, Tasmania. ALFRED T. FRY.

The Magnetic Separation of Pyrite and Blende

THE EDITOR:

Sir—I note the comments by Mr. E. Hedburg on "Magnetic Separation of Complex Lead and Zinc Ores" and his statement that differential floation is not only a difficult process but that the flotation concentrates produced are objectionable to the smelters. In his magnetic practice he roasts the iron sulphides until they are magnetic. We treat a zinc-pyrite concentrate at Edwards. The zinc is of the "Black Jack" variety, containing 5.25 per cent iron chemically combined in the zinc crystal.

Our mill consists of jigs and tables, which eliminate the limestone and give and iron-pyrite-zincblende concentrate. This concentrate contains two parts zincblende and one part iron pyrite. We pass the wet concentrate, which assays approximately 30 per cent, in water to the wet electric separating tables. These tables have steel riffles on reciprocating decks. Powerful magnets are suspended above and below these decks, and under the influence of the magnetic flux we so change the effective specific gravity of the zinc-blende crystal that it washes sideways across the riffles and the pyrite travels out between the steel riffles, as any sulphide concentrate would on an ordinary concentrating table. By this method we are able to raise the grade of our concentrate to a shipping product, and to produce a nearly clean pyrite. The cost of this operation is about 25c. per ton of concentrates so treated.

The machines, as operated at present, have a capacity of twenty-two tons per machine per twenty-four hours. They recover 95 per cent of the zinc fed them, 5 per cent being lost in the pyrite. No roasting is required, and if a greater tonnage were treated per day the operating cost could be reduced to approximately 10c. per ton. This cost is not the cost of the crude ore, but is based on the cost of treating 100 tons of mixed sulphide daily. These machines have been in operation at this property for several years and have treated over 150,000 tons of sulphide concentrates.

These machines are capable of separating zinc sulphide from iron pyrite and lead sulphides, provided the zinc sulphide is of the black variety. Iron and lead sulphides are unaffected by the magnetic forces. The machines are built by The Magnetic Ore Separator Co., and the inventor is Mr. Joseph Weatherby, Harrisburg, Pa. The machine will separate chalcopyrite from pyrite in a satisfactory manner. NORTHERN ORE COMPANY,

Edwards, N. Y. by W. R. Wade, Manager.

Metallurgical Engineers of Note

JOHN MICHAEL CALLOW

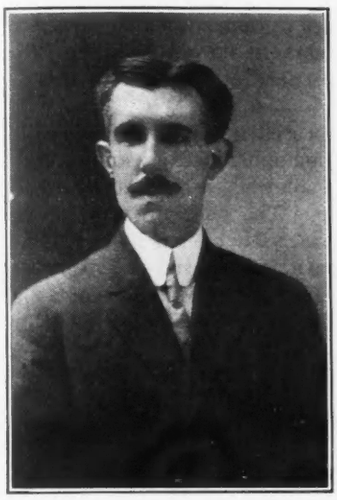
FEW MEN are better known or have attained a more enviable reputation in any part of the world where ores are subjected to mechanical concentration than John Michael Callow. He was born in the village of North Repps, Norfolk, England, on July 7, 1867. At the age of sixteen, after receiving the ordinary English grammar-school education, he was apprenticed to a firm of engineers, also taking an engineering course in the Norwich School of Art, and the South Kensington examinations in applied science. Owing to somewhat poor health as a boy, his studies were broken into at the age of eighteen by a sea voyage on a sailing ship to Australia, he being away from home a year. It was during his visit to Australia that he had his first experience in mining and milling, at Ballarat and in a stamp mill at Charters Towers. He also spent some time on a cattle ranch in Queensland. In October, 1888, Mr. Callow sailed for New York and went from there direct to Colorado, where, upon advice of his physicians, he led an outdoor life, farming in partnership with a cousin for two years. From 1890 to 1893 he was associated as mechanical draftsman with the firm of Stearns-Roger at Pueblo and Denver, and in 1894 assisted the late Phillip Argall in the design of the Metallic Extraction Co.'s works near Florence, Colo., at that time the largest dry-crushing, roasting, cyanide leaching plant in the United States. Following some mining and milling experience in San Juan County, Colorado, in 1899 with the Golden Horn company, Mr. Callow joined the staff of Samuel Newhouse and moved to Salt Lake City, conducting experimental work on the Boston Consolidated ores at Bingham and at the Cactus mine, near Milford, later designing and building the Annie Laurie mill, a dry-crushing plant operating in Sevier County, Utah, on porphyry ores. It was during Mr. Callow's experimental work on the Cactus ores that he developed and placed on the market the settling tank and traveling-belt screen that bear his name and that have had such a world-wide application. About the same time he also devised what became known as the Callow cone. In 1906 Mr. Callow set up in business in Salt Lake City under the corporate name of the General Engineering Co., taking in with him two or three of his early associates, erecting their own building, conducting an ore-testing plant, and taking up the design and construction of ore-treatment plants. In 1914, after studying the flotation process for about five years, Mr. Callow applied for his first patent on the Callow pneumatic flotation machine, which has become so largely adopted and which perhaps more than anything else has made his name a household word among engineers and metallurgists. The Callow flotation machine was installed in the National Copper mill at Mullan, Idaho, in March, 1914, was a complete success from the start, and is now being used by many of the largest plants in the United States. Mr. Callow was consulting engineer for the Inspiration Copper Co. when that company's present mill was built, that being the first large-scale installation of the pneumatic cells which bear his name. During the eighteen years that Mr. Callow's company has been in business, it has tested thousands of different ores from all over the world, designed and built many mills, developed a number of machines both for laboratory use and mill practice, has established an eastern office in New York and agencies abroad, has lived through good times and hard times, and has become one of the best-known firms of metallurgical engineers, thanks to the guiding hand and ability of its president, John M. Callow. A clever inventor, a deep student, capable of unusual concentration, a most persistent and indefatigable worker, with a large amount of practical experience, he has honestly earned the enviable reputation that he has gained. Five years after coming to this country Mr. Callow returned to England, where he was married to Roberta Moore in 1893, returning to the United States soon after. They have four children, three of them being young ladies. Though he makes his home in Denver, Mr. Callow is a frequent visitor to New York and to the various mining camps of the country. He is a member of the A.I.M.E. and is now serving on the Institute committee on milling methods.

JOHN MICHAEL CALLOW

The Equilibrium Diagram of the System Cu_2S—FeS

An Investigation of Reactions Which Have an Important Application in the Smelting of Copper Sulphide Ores

BY CLARK B. CARPENTER
Associate Professor of Metallurgy, Colorado School of Mines
AND
CARLE R. HAYWARD
Associate Professor of Metallurgy, Massachusetts Institute of Technology



Carle R. Hayward

Clark B. Carpenter

RÖNTGEN was probably the first to attempt a serious investigation of the equilibrium relations of the system Cu_2S—FeS. Data concerning the character and composition of the sulphides used by him are not available, but his results are plotted in Fig. 1. He found the melting point for iron sulphide to be 1,133 deg. C. and for copper sulphide to be 1,085 deg. C. He also found a series of seven compounds, and at least one definite eutectiferous range lying between the limits iron sulphide 80 per cent and iron sulphide 60 per cent and having a melting point of about 890 deg. C.

Baykoff and Troutneff were the second investigators who attempted to determine the equilibrium of this system. These investigators found that the two sulphides were completely soluble in each other in all proportions when just molten, and also when just solid, the liquidus showing a minimum freezing point at about 955 deg. C. (Fig. 1), with a composition of 55 per cent FeS and 45 per cent Cu_2S. No points of similarity exist between the results obtained by these two investigators and those obtained by Röntgen.

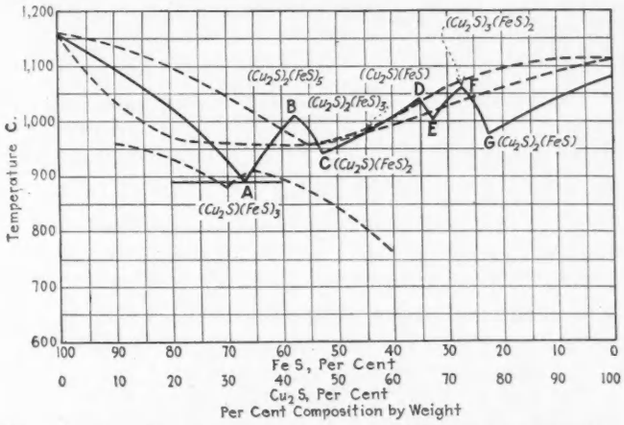


Fig. 1—Results of investigations by Baykoff and Troutneff (indicated by broken line), and by Röntgen (indicated by full line)

Bornemann and Schreyer at a slightly later date made a further investigation of the system, resulting in the discovery of at least four compounds (Fig. 2), a series of solid solutions, a transformation in the solid state at 915 deg. C. between the limits iron sulphide 89.5 per cent and iron sulphide 50 per cent, and a eutectiferous range between the limits FeS 87 per cent and FeS 52 per cent having a melting point of about 970 deg. C. The curve obtained by Bornemann and Schreyer in its general outline closely resembles that obtained by Röntgen and does not in the least resemble that obtained by Baykoff and Troutneff. The work of Bornemann and Schreyer was the last attempted so far as published results show, but it is known that research has been conducted in several laboratories, the results of which has not been published.

In the work to be described FeS was prepared from sulphur and Swedish wrought iron. The iron was examined microscopically, but was not analyzed for iron content. The microscopical examination revealed that the material contained a remarkably small amount of slag. The iron was cut into pieces about 4½ in. long, placed in a No. 12 graphite crucible, and heated in a coke pot furnace to a bright redness, at which time sulphur was thrown on it. When all the iron had apparently united with the sulphur, the material was heated until thoroughly fused, when the entire melt was poured into an iron mold, cooled, broken into small pieces, re-

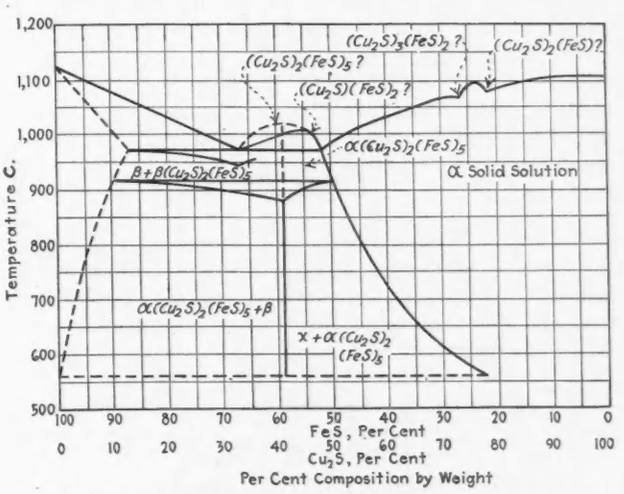


Fig. 2—Results secured by Bornemann and Schreyer

packed in the crucible with sulphur, and again melted. This procedure was continued until no more sulphur was taken up by the melt, as shown by analyses made from time to time during the preparation of the sulphide. The only exception to the above procedure was that after the melt had absorbed all the sulphur it would hold, the fusion was allowed to cool in the graphite crucible, and, after cooling, the crucible was broken away from the cold sulphide, which was thereupon carefully cleaned of all pieces of adhering crucible material. The final product was a crumbly, crystalline material having the composition Fe, 63.27 per cent; "insoluble," 0.47 per cent; and S, by difference, 36.26 per cent. The FeS content, calculated on the assumption that all the iron exists as sulphide, was 99.52 per cent.

Preparation of the Copper Sulphide

The Cu_2S was prepared from specimens of electrolytic copper furnished by the Perth Amboy plant of the American Smelting & Refining Co. The original material analyzed: Cu, 99.93 per cent; Fe, trace; S, 0.042 per cent; O, 0.056 per cent. The copper was sawed into small pieces, placed in a No. 12 graphite crucible in the pot furnace, and boiled in sulphur until no further traces of metallic copper were evident. The partly sulphidized material was next melted with more sulphur, poured into a mold, cooled, broken into small pieces, repacked in the crucible with more sulphur, and again melted. This procedure was continued until the melt would take up no more sulphur as shown by analyses made from time to time during the preparation of the sulphide. It was then allowed to cool in the crucible, and after cooling the crucible was broken away from the cold sulphide, which was thereupon cleaned of all adhering particles of the crucible material. The final sulphide was a dense lustrous material, analyzing: Cu, 79.75 per cent; S, 20.06 per cent; Fe, trace; "insoluble" (by difference), 0.19 per cent; and having a Cu_2S content, based on the copper analysis, of 99.83 per cent.

The sketch of the furnace used in determining the cooling curves is shown in Fig. 3. It is a carbon resistance type furnace, using in this instance Kryptol instead of carbon for resistance material. The furnace was connected in series with a 115-volt a.c. circuit, through an ammeter, and a carbon resistance control to regulate as much as possible the current used by the furnace. The current could be held down to 60 amperes with comparative ease, and with that current flowing it was quite easy to reach a temperature of 1,300 deg. C. in twenty-five minutes.

The temperatures were measured by a platinum-rhodium thermocouple connected to a Leeds and Northrup continuous curve drawing potentiometer. It has three distinct ranges, and a guaranteed accuracy of one-half of 1 per cent throughout its entire range. Fig. 5, shows a typical cooling curve obtained with this instrument.

The pyrometer was calibrated by obtaining the millivolt deflection produced when substances of known melting point were melted and allowed to cool slowly in the kryptol resistance furnace. The cold junction of the thermocouple was kept in a bath of ice in a thermos bottle during all determinations. As the potentiometer has three distinct ranges, that range was chosen which would give the greatest deflection using a platinum-rhodium thermocouple, with the result that the deflection was four times what it normally would have been.

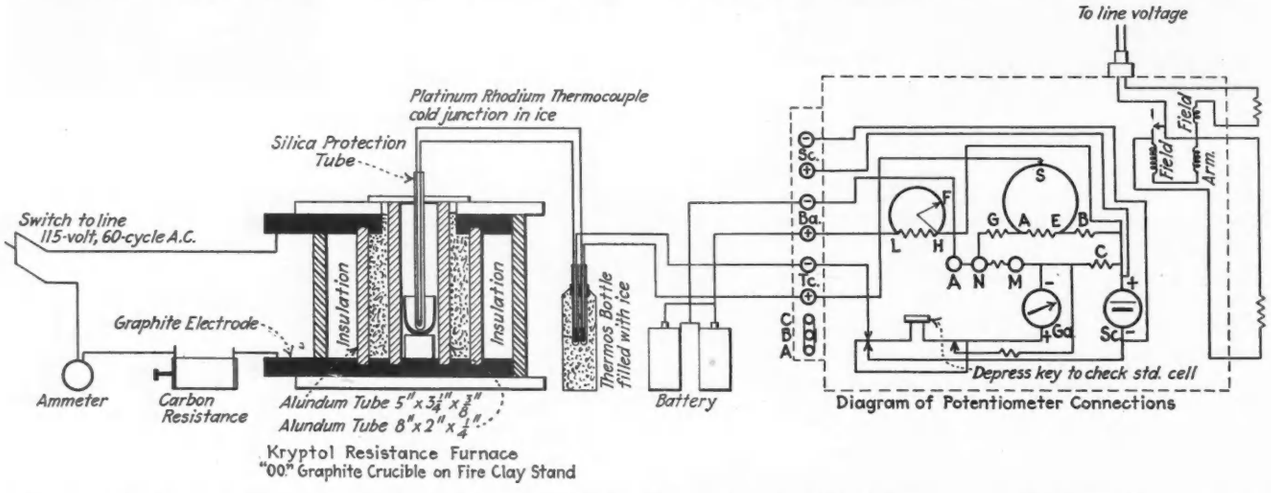


Fig. 3—Resistance furnace used in tests, (see Jeffries. Gran-Annular Electric Furnace, "Met. & Chem. Eng.," Vol. 12, 1914, p. 154. Also, Fulton, "Constitution and Melting Points of Copper Slags," "Transactions" A.I.M.E., Vol. 44, 1912, p. 769)

The substances used in calibration were zinc, salt, and copper. All these were melted in graphite crucibles, using a cover of petroleum coke. The freezing points and deflections obtained were as follows:

	±Degrees C.	Millivolts Deflection
Freezing point of zinc	420	9.2
Freezing point of salt	800	24.2
Freezing point of copper	1,083	36.8

The standardization was rechecked from time to time during the taking of the cooling curves, but no appreciable changes were found.

The charge used in determining the cooling curves consisted in all instances of 100 grams of material in a No. 00 graphite crucible. The fusions were made under a cover of petroleum coke to exclude all possibility of oxidation, and the atmosphere in the furnace was also a reducing one owing to CO gas from the hot kryptol. The hot junction of the thermocouple was protected by a fused silica tube. One heating curve and one cooling curve only were run for each melt unless for some reason a poor curve was obtained, whereupon the fusion was repeated until concordant results were obtained.

It will be noted that the freezing point of iron sul-

Table I—Data From Which the Equilibrium Diagram (Fig. 4) Was Constructed

Percentage Composition of Charge		Temperature of Retardation, Degree C.		
FeS	Cu_2S			
100	0	1,163		
90	10	1,140	1,005	948
		1,130		
85	15	1,100	1,000	952
80	20	1,070	1,000	950
		1,076	995	946
75	25	1,045	995	950
72.5	27.5	1,007		950
70	30	1,000		951
		997		952
69	31	1,006		952
68	32	1,005		950
67.5	32.5	995		950
65	35	996		950
		984		
62.5	37.5	995		951
60	40	998		950
		997		952
50	50	1,008	990	
		1,002		
45	55	1,042		
40	60	1,060		
		1,050		
35	65	1,062		
30	70	1,068		
		1,070		
20	80	1,100		
10	90	1,115		
		1,110		
0	100	1,128		

phide is given as 1,163 deg. C. Others who have investigated this system have found freezing points considerably at variance with this value. It must be borne in mind, however, that considerable difficulty is encountered in the manufacture of iron sulphide because iron is soluble in iron sulphide (Friedrich, *Metallurgie*, Vol. 7, 1910, p. 257 *et seq.*), and therefore it is easy to obtain an iron sulphide that closely approximates the theoretical, but decidedly difficult to completely sulphidize all the traces of iron. Various investigators have found the freezing point[1] of FeS as follows (Fulton, "Principles of Metallurgy," 1910, pp. 292 to 294):

Freezing Point of FeS

Investigator	Composition of Sulphide Fe	S	Freezing Point Degrees C.	Substance
Friedrich, *Metallurgie*, Vol. 56	63.59	36.41	1,171	FeS
Bornemann, *Metallurgie*, Vol. 64	63.59	36.41	1,194	FeS
Bornemann, *Metallurgie*, Vol. 64	63.70	36.21	1,189	FeS plus Fe
Bornemann, *Metallurgie*, Vol. 64	63.25	36.75	1,203	FeS plus S
Friedrich, *Metallurgie*, Vol. 56	61.75	38.25	1,192	FeS plus S
Röntgen, *Metallurgie*, Vol. 3, p. 479	?	?	1,133	?
Tammann *Zeit. fur Anor. Chemie*, Vol. XLIX, p. 320	?	?	1,300	?
Bornemann, *Metallurgie*, Vol. 6, p. 619	99.58 per cent FeS		1,158	?

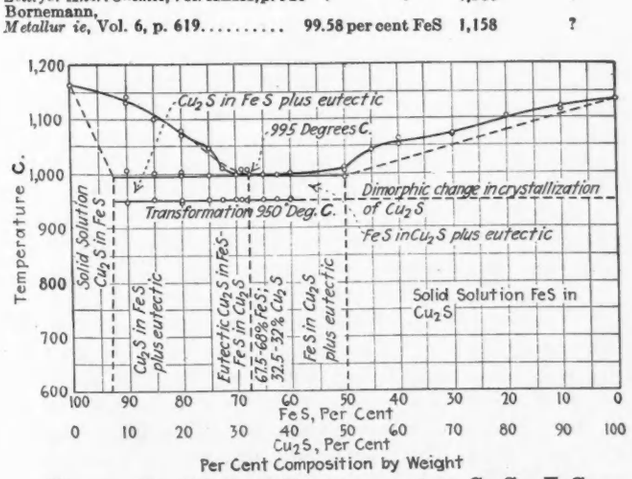

1,200
1,100
1,000
900
800
700
600
Temperature C.
Cu_2S in FeS plus eutectic
995 Degrees C.
Dimorphic change in crystallization of Cu_2S
Transformation 950 Deg. C.
FeS in Cu_2S plus eutectic
Solid Solution Cu_2S in FeS
Cu_2S in FeS plus eutectic
Eutectic Cu_2S in FeS; FeS in Cu_2S; 67.5-68% FeS; 32.5-32% Cu_2S
FeS in Cu_2S plus eutectic
Solid Solution FeS in Cu_2S
100 90 80 70 60 50 40 30 20 10 0
FeS, Per Cent
0 10 20 30 40 50 60 70 80 90 100
Cu_2S, Per Cent
Per Cent Composition by Weight

Fig. 4—Equilibrium diagram, system Cu_2S—FeS

Of these data we do not consider the temperatures obtained by Tammann, Röntgen, and Bornemann (Fe, 63.25; S, 36.75) to be reliable. The discrepancies existing between the freezing points obtained by Friedrich and Bornemann, both using FeS of theoretical composition, can be accounted for possibly by the type of apparatus used.

Similar discrepancies exist in the freezing point determinations for cuprous sulphide (Cu_2S). Here again it must be borne in mind that copper is soluble in cuprous sulphide (Heyn and Bauer, *Metallurgie*, Vol. 3, 1906, p. 73) and that the last remaining traces of metallic copper do not readily sulphidize. The composition of the cuprous sulphide used and the freezing points obtained by various investigators are as follows: (Fulton, "Principles of Metallurgy," 1910, pp. 292 to 294):

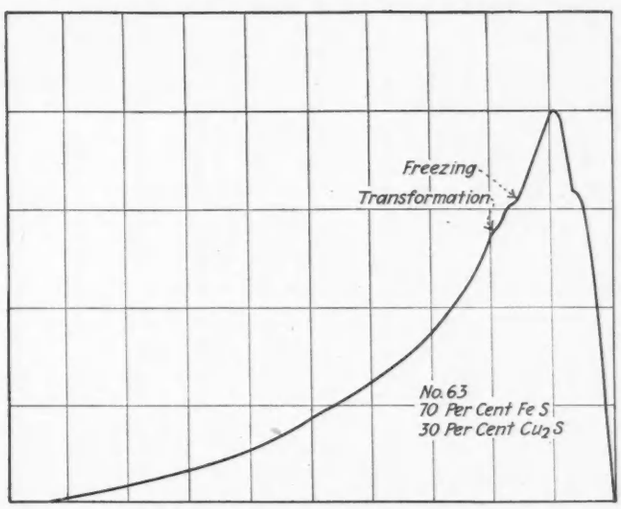


Fig. 5—Typical cooling curve

Freezing Point of Cu_2S

Investigator	Composition of Sulphide		Freezing Point, Degrees C.	Substance
Heyn and Bauer, *Metallurgie*, Vol. 3, p. 78	Cu_2S	99.71	1,127	$Cu_2S + S$
Friedrich, *Metallurgie*, Vol. 52	Cu_2S	100	1,135	Cu_2S
Friedrich, *Metallurgie*, Vol. 52	Cu_2S	78.6	1,101	$Cu_2S + S$
Röntgen, *Metallurgie*, Vol. 3, p. 479			1,085	Cu_2S (?)
Heyn and Bauer, *Metallurgie*, Vol. 3	Cu_2S / Cu	95 / 5	1,110	$Cu_2S + Cu$
Bornemann and Schreyer, *Metallurgie*, Vol. 6, p. 619	Cu_2S	99	1,105	$Cu_2S + S$
Hayward, *Bulletin* A. I. M. E.	Cu_2S	99.13	1,130	$Cu_2S + S$

It is probable that the freezing point obtained by Friedrich using 100 per cent Cu_2S is correct, and that obtained by Heyn and Bauer using 99.71 per cent Cu_2S is correct for that composition, but it is doubtful if the other freezing points are in agreement with the composition of pure cuprous sulphide.

The equilibrium diagram (Fig. 4) is of the usual type in which the sulphides are completely soluble in each other when liquid, but only partly soluble in each other when solid, the two branches of the liquids curve intersecting at a point below the freezing points of the pure constituents. There is a decided eutectiferous range extending from about 92.5 per cent FeS to 50 per cent FeS. A transformation in the solid state at high temperature between the same limits is also present. There are no indications of the presence of chemical compounds, and no evidences of transformations in the solid state at low temperatures. The diagram is, with the exception of the transformation in the solid state, self-explanatory.

[1] Fulton records these as melting points, but they are more accurately designated as freezing points.

The eutectic of FeS and Cu_2S is present in all mixtures between 90 per cent FeS and 50 per cent FeS. It is absent in mixtures containing 95 per cent FeS; consequently, the upper limit falls between 90 per cent FeS and 95 per cent FeS, but the exact position was not determined. The ratio of eutectic to iron-rich solid solution increases rapidly until the composition, 68 per cent FeS, 32 per cent Cu_2S, is reached, when the amount of iron-rich solid solution is very small, indicating that the eutectic composition is close to this composition. A mixture was then tried containing FeS 67.5 per cent, Cu_2S 32.5 per cent, but it was found on examination that the quantity of eutectic was, if anything, slightly less than in the preceding melt. The eutectic composition has therefore been indicated as falling between 67.5 per cent FeS and 68 per cent FeS.

A curious phenomenon was noted in certain melts of composition ranging from FeS 45 per cent to FeS 15 per cent. This phenomenon consisted of a swelling of the cooling charge and was always accompanied by the separation of metallic copper. Bornemann and Schreyer (*Metallurgie*, Vol. 6, 1909, p. 619 *et seq.*) observed this same phenomenon. In explanation of it they have reviewed the opinion of Röntgen (*Revue de Metallurgie*, Vol. 3, 1906, p. 484), who held that the metallic copper present is due to the formation of the iron sulphide FeS_2, but neither Röntgen nor Bornemann and Schreyer have offered any proof for their contention; in fact, Bornemann and Schreyer state that "one can consider that the metallic copper does not exist"—a contention with which few will agree. Baykoff and Troutneff (*Revue de Metallurgie*, Vol. 6, 1909, p. 519) likewise observed the swelling of the cooling charge and the bursting of the crucible. They have advanced the explanation that the swelling is due to the separation of metallic copper, which seems probable. To explain the appearance of the copper they have advanced two chemical reactions between Cu_2S and FeS, either one of which would result in the formation of metallic copper.

The first reaction results in the formation of metallic copper and chalcopyrite:

$$Cu_2S + FeS = Cu + CuFeS_2$$

and the second reaction results in the formation of metallic copper and a peculiar mixture of sulphides thus:

$$2\,Cu_2S + FeS = (CuS, Cu_2S/FeS) + Cu$$

The reactions, from a theoretical standpoint, balance, but a decided gap exists between the writing of a chemical equation and the probable occurrence of the reaction.

In the present research the greatest precipitation of metallic copper was found to be in mixtures containing 75 per cent Cu_2S, 25 per cent FeS, but in certain melts less metallic copper had formed than in others of the same composition. An attempt was therefore made to prove whether the amount of metallic copper was a function of the temperature to which the mixtures were heated during melting. For this, two mixtures were chosen, each containing 75 per cent Cu_2S and 25 per cent FeS. The first was heated to a temperature of 1,260 deg. C., or about 190 deg. C. above the melting point, and then allowed to cool slowly in the furnace. The second melt was heated to about 1,120 deg. C., or about 50 deg. above the melting point, and then allowed to cool slowly in the furnace. In cooling, the melt heated to 1,260 deg. C. swelled and burst the crucible, whereas the melt heated to 1,120 deg. C. solidified without apparent swelling. Both specimens were next ground down longitudinally, polished, and examined for metallic copper. The melt heated to 1,260 deg. C. showed much metallic copper, whereas that heated to 1,120 deg. C. showed but little metallic copper. No attempt was made to measure the areas of solid solution and of metallic copper.

Why Iron Is Present in Siliceous Mattes

The fact that in the specimen heated to 1,260 deg. C. there was much metallic copper appears to be in accordance with certain facts well known concerning the two sulphides, FeS and Cu_2S. Le Chatelier and Ziegler (*Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, Vol. CIII, 1902, p. 368) have shown conclusively that FeS when heated to temperatures above 1,200 deg. C. loses sulphur by distillation, leaving behind metallic iron. This fact offers an easy and logical explanation for the occurrence of metallic iron in siliceous mattes. It likewise furnishes a foundation for the argument that the metallic iron formed reacts with the Cu_2S to form Cu and FeS according to the equation

$$Fe + Cu_2S = 2Cu + FeS$$

This is a reaction capable of experimental proof. To this end two experiments were tried using iron filings and Cu_2S as the charge, and in each instance a copper button was obtained and a matte filled with small pieces of metallic copper.

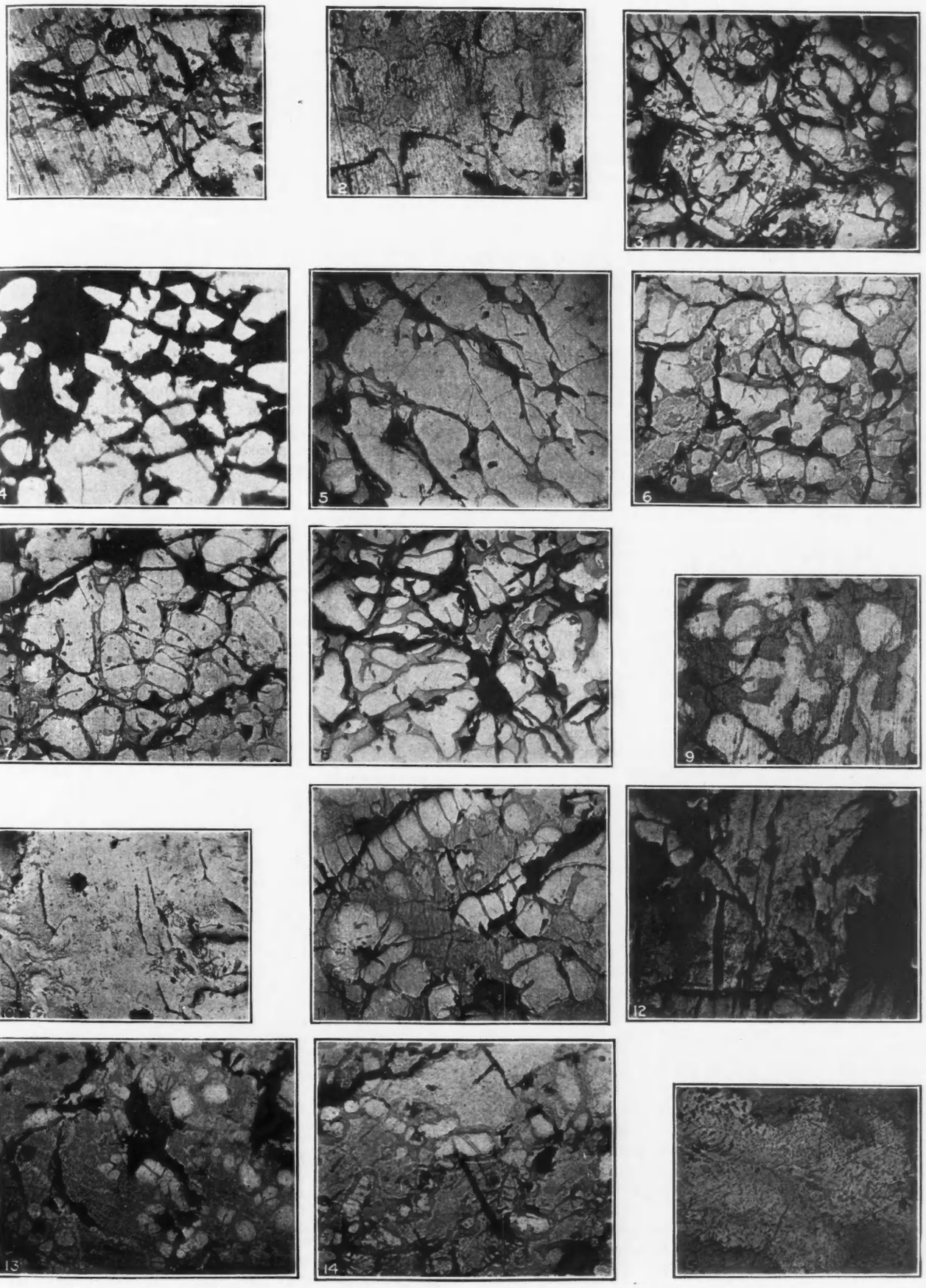
Baykoff and Troutneff (in the previous citation) have maintained that Cu_2S loses sulphur in like manner, but if this is so it seems strange that no metallic copper was found when heating pure Cu_2S well above its melting point.

The question naturally arises as to metallic copper being an equilibrium product. To determine this, several mixtures ranging in composition from 50 per cent FeS to 10 per cent FeS were prepared, melted very carefully, and allowed to cool slowly in the furnace to room temperature. The solid buttons of matte were then placed in an electric muffle furnace, heated slowly to 1,000 deg. C., and held at that temperature for twenty-four hours. The specimens were then cooled slowly in the furnace, ground down longitudinally, polished, and examined. The polished specimens showed no free metallic copper, so if any was formed it had been absorbed.

The results of efforts working with melts in which metallic copper occurs actually confirms the results of Bornemann and Schreyer, previously mentioned, but the conclusion has been arrived at in an entirely different way.

It seems probable that by carefully regulated methods of melting, taking special care not to heat too long or at too high a temperature, it is possible to reduce the presence of metallic copper to a minimum if not to eliminate its presence entirely.

The mattes in which the metallic copper was observed are all above the range of commercial mattes. To ascertain the effect of prolonged heating on lower-grade mattes, three melts were made in graphite crucibles using 20 grams Cu_2S and 30 grams FeS corresponding to the chemical composition Cu, 31.9; Fe, 39.2; and S, 29.9 per cent. The mixtures were covered with charcoal and the temperature of the furnace was maintained at 1,100 deg. C. for three and three-quarter hours. One crucible was removed after forty-five minutes, another after an additional hour, and the third after a further time of two hours. When cold, the matte buttons were crushed, sampled, and analyzed for sulphur. The values



Photomicrographs of FeS—Cu_2S mixtures, Nos. 1 to 15. (About × 50)

obtained were 28.69, 28.63, and 28.25 per cent respectively, indicating a loss during melting followed by a gradual loss by distillation of sulphur from the molten matte.

It seems fair to assume from the above facts that the loss of sulphur in a reverberatory smelting furnace which has usually been ascribed entirely to oxidation may to some extent be due to distillation, the amount of such distillation being a function of the temperature of the bath and the time the molten matte remains in the furnace. It is probable that the change in the matte composition in the reverberatory would be greater than the change under the reducing conditions obtaining in the crucible, for in the furnace the iron freed by the distillation of the sulphur would be to a large extent oxidized and would enter the slag. The reason for the non-appearance of metallic copper in the low-copper mattes is probably due to the fact that the iron freed by the distillation of sulphur is dissolved by the excess FeS present instead of reacting with the Cu_2S.

There remains to be discussed the transformation in the solid state occurring at 950 deg. C. Just what causes this transformation is not wholly apparent. However, it is probable that it is due to a dimorphic change in the crystal habit of one of the two constituents, probably the Cu_2S. For a while the change was considered as being concerned with the FeS, but Le Chatelier and Ziegler (in the previous citation) found that the change in the FeS took place at about 130 deg. C., and therefore it cannot be looked upon as contributing to the transformation now under discussion. Baykoff and Troutneff (previous citation) maintain that at elevated temperatures Cu_2S crystallizes as octahedra of the cubic system, whereas at low temperatures it is rhombohedral (Hayward, *Bulletin* A.I.M.E., February, 1914; Bornemann, *Metallurgie,* Vol. V, 1908, p. 13). In this connection we wish to refer to the opinion of Rosenhain ("Hardness of Solid Solution," *Proceedings of Royal Society,* Series A, Vol. 99, 196 *et seq.*), who says that X-ray analysis proves that in a metallic crystal the atoms of the metal are arranged in certain definite ways on a space lattice, and that the arrangement may vary in detail from one metal to another, not only in regard to the nature of the lattice (cubical or otherwise) and the occupied points, but also in regard to the normal interatomic distance or lattice of the metal.

What has been said concerning solid solutions of metals applies with equal force to all solid solutions. It is possible to imagine in a case like the present that the percentage of FeS in great excess over that of Cu_2S would delay the crystalline change in the Cu_2S until the tendency for the change to take place becomes so great as to overcome the effects of the FeS. With decreasing percentages of FeS and increasing percentages of Cu_2S the change would take place with greater ease and with less evolution of heat and would eventually disappear or become so slight as to escape unnoticed. This was actually found from the cooling curves to be the case, and it likewise furnished an explanaton for the transformation in mixtures containing less than 55 per cent FeS.

The discussion immediately preceding is more or less speculative, but in an attempt to solve the problem ten samples were prepared as follows:

FeS melted and cooled slowly in the furnace.

FeS melted and quenched from freezing in ice water.

FeS 80 per cent, Cu_2S 20 per cent. Cooled slowly in furnace.

FeS 80 per cent, Cu_2S 20 per cent. Quenched from freezing in ice water.

FeS 70 per cent, Cu_2S 30 per cent. Cooled slowly in furnace.

FeS 70 per cent, Cu_2S 30 per cent. Quenched from solidification point in ice water.

Cu_2S cooled slowly in the furnace.

Cu_2S quenched from solidification point in ice water.

FeS 80 per cent, Cu_2S 20 per cent. Quenched from liquid by pouring into ice water.

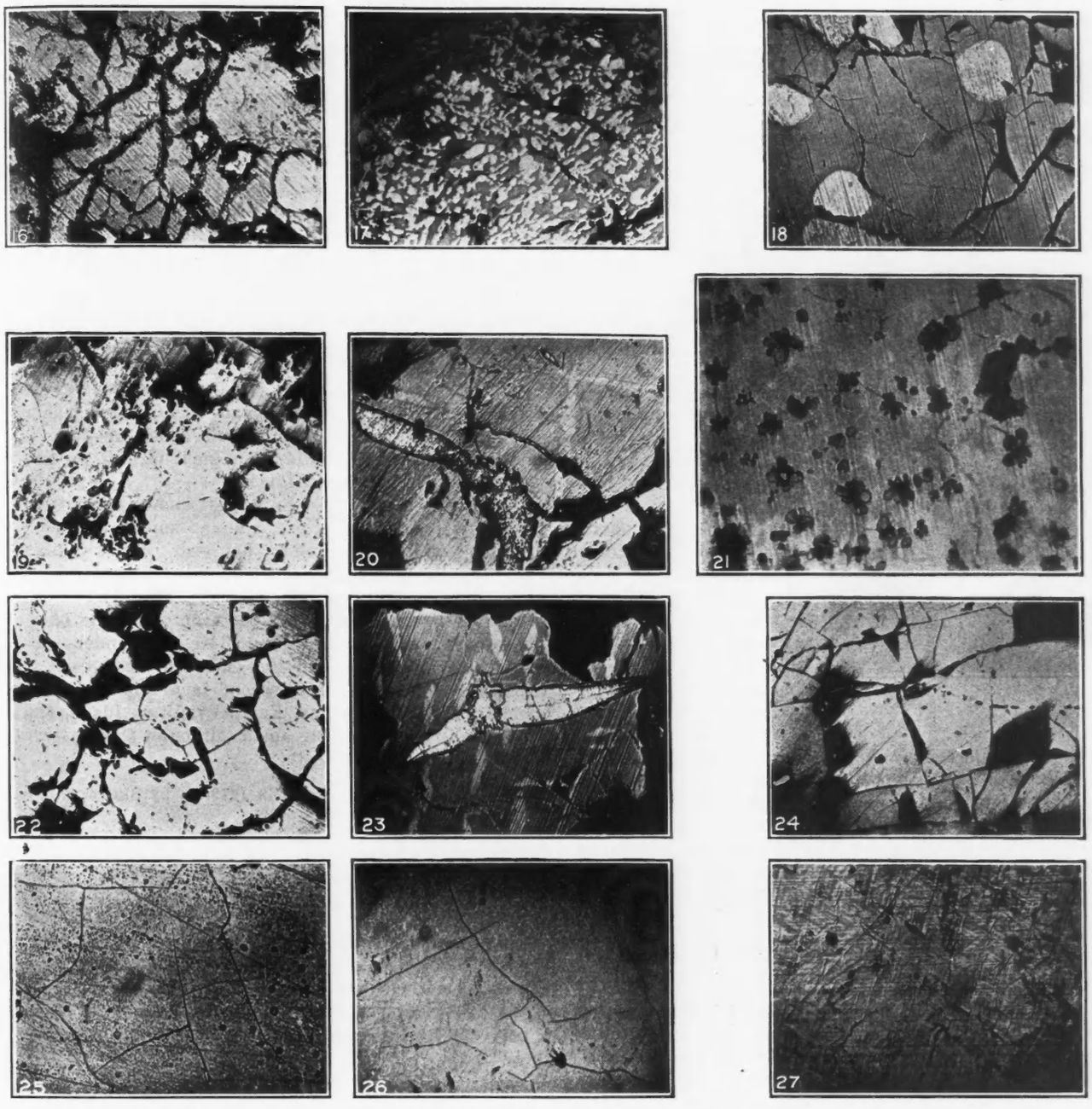
FeS 70 per cent, Cu_2S 30 per cent. Quenched from liquid by pouring into ice water.

These samples were submitted to E. C. Bain, Cleveland Wire Division, National Lamp Works, of the General Electric Co., Cleveland, Ohio, for X-ray examination. Mr. Bain's report bears out the contention that the Cu_2S is soluble in FeS. There was no difference in pattern between the quenched specimens and those cooled slowly in the furnace, indicating that the exothermic reaction cannot be prevented by quenching. Unfortunately, no samples containing over 50 per cent Cu_2S were submitted for X-ray examination, and consequently no results are available to strengthen or weaken the conclusions reached concerning melts containing over 50 per cent Cu_2S.

Key to Photographs

Note: No photograph of the microstructure of FeS was obtained, for the material was entirely too brittle to permit polishing.

1. 90 per cent FeS, 10 per cent Cu_2S. Cooled slowly in furnace. Eutectic + FeS-rich solid solution.
2. 80 per cent FeS, 20 per cent Cu_2S. Cooled slowly in furnace. Eutectic + FeS-rich solid solution.
3. 80 per cent FeS, 20 per cent Cu_2S. Quenched from freezing. Eutectic + FeS-rich solid solution.
4. 80 per cent FeS, 20 per cent Cu_2S. Quenched at eutectic. Eutectic + FeS-rich solid solution.
5. 80 per cent FeS, 20 per cent Cu_2S. Quenched at 950 deg. C. Eutectic + FeS-rich solid solution.
6. 75 per cent FeS, 25 per cent Cu_2S. Quenched at freezing. Eutectic + Fe-S rich solid solution.
7. 75 per cent FeS, 25 per cent Cu_2S. Quenched at eutectic. Eutectic + FeS-rich solid solution.
8. 75 per cent FeS, 25 per cent Cu_2S. Quenched at 950 deg. C. Eutectic + FeS-rich solid solution.
9. 70 per cent FeS, 30 per cent Cu_2S. Cooled slowly in furnace. Eutectic + FeS-rich solid solution.
10. 68 per cent FeS, 32 per cent Cu_2S. Cooled slowly in furnace. Almost entirely eutectic.
11. 67.5 per cent FeS, 32.5 per cent Cu_2S. Quenched at eutectic. Probably eutectic + slight amount of Cu_2S-rich solution.
12. 67.5 per cent FeS, 32.5 per cent Cu_2S. Quenched at 950 deg. C. Same as for No. 11.
13. 67 per cent FeS, 35 per cent Cu_2S. Quenched at freezing. Euctectic + Cu_2S-rich solid solution.
14. 65 per cent FeS, 35 per cent Cu_2S. Quenched at 950 deg. C. Same as for No. 13.
15. 60 per cent FeS, 40 per cent Cu_2S. Cooled slowly in furnace. Cu_2S-rich solid solution, with a small amount of eutectic.
16. 50 per cent FeS, 50 per cent Cu_2S. Cooled slowly in furnace. Almost entirely Cu_2S-rich solid solution.
17. 50 per cent FeS, 50 per cent Cu_2S. Cooled slowly in furnace. Annealed at 1,000 deg. C. for twenty-four hours and cooled slowly in the furnace. Cu_2S-rich solid solution with very slight amount of eutectic.
18. 40 per cent FeS, 60 per cent Cu_2S. Cooled slowly in furnace. Cu_2S-rich solid solution with unabsorbed constituent.
19. 40 per cent FeS, 60 per cent Cu_2S. Cooled slowly in furnace. Annealed at 1,000 deg. C. for twenty-four hours, cooled slowly in furnace. Cu_2S-rich solid solution. Unabsorbed constituent disappeared.
20. 30 per cent FeS, 70 per cent Cu_2S. Cooled slowly in furnace. Cu_2S-rich solid solution + metallic copper.



Photomicrographs of FeS—Cu_2S mixtures, and pure Cu_2S, Nos. 16 to 27. (About × 50)

21. 30 per cent FeS, 70 per cent Cu_2S. Cooled slowly in furnace. Cu_2S-rich solid solution.

22. 30 per cent FeS, 70 per cent Cu_2S. Cooled slowly in furnace. Annealed at 1,000 deg. C. for twenty-four hours, cooled slowly in furnace. Cu_2S-rich solid solution.

23. 20 per cent FeS, 80 per cent Cu_2S. Cooled slowly in furnace. Cu_2S-rich solid solution, copper and unabsorbed constituent.

24. 20 per cent FeS, 80 per cent Cu_2S. Cooled slowly in furnace. Cu_2S-rich solid solution. Unabsorbed constituent has disappeared, as has also the metallic copper.

25. 10 per cent FeS, 90 per cent Cu_2S. Cooled slowly in furnace. Cu_2S-rich solid solution.

26. 10 per cent FeS, 90 per cent Cu_2S. Cooled slowly in furnace. Annealed at 1,000 deg. C. for twenty-four hours, cooled in furnace. Cu_2S-rich solid solution.

27. 100 per cent Cu_2S cooled slowly in furnace.

Conclusions

From the work done, as detailed in this presentation, the following conclusions have been drawn:

1. The system Cu_2S—FeS forms a solid solution at the FeS end of the series with limiting solubility at about 92.5 per cent FeS and at the Cu_2S end of the series with limiting solubility at 50 per cent Cu_2S.

2. The eutectic range extends from about FeS 92.5 per cent to FeS 50 per cent.

3. The eutectic composition falls between FeS 68 per cent and FeS 67.5 per cent with a melting point of 995 deg. C.

4. There is a transformation in the solid state at 950 deg. C., which is probably attributable to dimorphic change in the Cu_2S.

5. There are no compounds between Cu_2S and FeS.

6. The freezing point of FeS is 1,163 deg. C. and of Cu_2S is 1,128 deg. C.

7. A loss of sulphur takes place by distillation from molten FeS. The resulting Fe in part dissolves in the remaining FeS and in part reacts with Cu_2S, producing Cu and FeS.

The Marketing of Phosphate Rock

Principal Production From the Southern and Western States—Many Grades Sold—Exports to Europe an Important Factor—Typical Contracts Shown

By R. W. Stone
Assistant State Geologist, Harrisburg, Pa.

R. W. Stone

PHOSPHATE ROCK is chiefly used, after treatment with acid, as an ingredient of artificial fertilizers. A small quantity is finely ground and used directly as fertilizer. Lesser quantities find application in making phosphoric acid and phosphorus. Phosphorus is a common ingredient of matches and the striking surface on boxes of safety matches; it enters in small proportion into phosphor-bronze, phosphor-copper, and phosphor-tin, and also is used for incendiary bullets and smoke screens, and in sundry other applications.

The quantity of phosphate rock consumed raw by farmers for direct application to the soil is less than 100,000 tons annually, compared with a total domestic consumption of approximately 1,500,000 tons. The principal users of phosphate rock are the manufacturers of fertilizers. Some of these manufacturers mine the rock themselves.

Various Forms in Which Phosphate Rock May Occur

Phosphate rock is a sedimentary deposit containing phosphate of lime. It occurs as a hard rock interstratified with beds of sandstone, shale, or other sediments; as amorphous nodular concretions or pebbles in stream deposits; and as a residuum from the decomposition of phosphatic dolomite or limestone, or other rocks containing phosphate of lime. Another type of deposit commonly classed as phosphate rock is the porous coralline or other limestone of tropical islands which has been permeated with phosphate leached from guano.

Phosphate deposits of the western United States, Algeria, Tunis, Morocco, and Egypt are hard-rock beds of the first type. Amorphous nodular deposits occur in South Carolina, part of Florida, Wales, England, Belgium, north-central and eastern France, and Russia. The deposits in Tennessee, Kentucky, and some of those in Florida are residual. Leached guano deposits are found on the islands of Aruba, Curacao, and Sombrero, in the West Indies, and on Christmas, Ocean, Makatea, Angaur, and other islands in the Indian and South Pacific oceans.

The reserves in the United States are fairly well known and are estimated at 6,000,000,000 tons. Reserves of high-grade rock in Algeria and Tunis have been estimated at 300,000,000 tons. No information is at hand regarding the quantity of phosphate rock in Egypt, Morocco, or in Europe, except that Russia is believed to have 80,000,000 tons in one of its fields. The deposits in the South Pacific islands are estimated at 70,000,000 tons.

The world's output of phosphate rock is 4,000,000 to 6,000,000 tons annually, of which about one-half is mined in the United States. The next largest production is made in northern Africa.

The United States has the largest known deposits of phosphate rock in the world, and can supply the needs of other countries as well as her own. Since mining began, in 1868, about 60,000,000 tons have been mined, or 1 per cent of the reserves.

Florida produces about 80 per cent of all the phosphate rock mined in the United States, but under ordinary conditions more than 40 per cent of her output is exported. Tennessee ranks second in production. The yield from South Carolina, Kentucky, Utah, Idaho, and Montana is comparatively small, although the western states contain large deposits.

Phosphate Rock Mined in 1919-21, by States

In Long Tons

State	1919	1920	1921
Florida	1,254,609	3,255,720	2,088,251
South Carolina	49,032	42,709	
Tennessee and Kentucky	530,973	627,677	332,962
Western States	16,935	48,895	4,961
Totals	1,851,549	3,975,001	2,426,174

The following table shows the proportion of total exports to total sales of domestic rock in the United States from the years 1913 to 1921. The exports decreased from 44 per cent of the production in 1913 to 6 per cent in 1917 and 1918, but rose to 35 per cent in 1921.

Phosphate Rock Marketed in and Exported From the United States, 1913-1921

Year	Quantity Marketed (Long Tons)	Exports (Long Tons)	Proportion of Exports to Total Sales (Per Cent)
1913	3,111,221	1,366,508	44
1914	2,734,043	964,114	35
1915	1,835,667	253,421	14
1916	1,982,385	243,678	12
1917	2,584,287	166,358	6
1918	2,490,760	143,455	6
1919	2,271,983	378,731	17
1920	4,103,982	1,069,712	26
1921	2,064,025	733,312	35

As the use of complete fertilizers is largest in the long-cultivated soils of the cotton, corn, and tobacco fields of the eastern and southern states, and as phosphate rock constitutes less than one-half of those fertilizers, it follows that the fertilizer manufacturing plants are in the areas of large consumption. Phosphate rock for domestic use goes from the washing and drying plants near the mines directly to the fertilizer factories. Complete fertilizer plants with acid chambers, and plants without acid chambers, but having rock-grinding and acidulating machinery, are most numerous in Ala-

bama, Georgia, Maryland, North Carolina, South Carolina, Virginia, and Ohio. Other states not unimportant as users of phosphate rock for manufacturing fertilizer are Florida, Texas, and California. Georgia has by far the largest number of fertilizer plants of all kinds, including dry mixing plants.

As most of the phosphate is produced in Florida and Tennessee and most of the factories are in the neighboring states in the cotton and tobacco belt, it is apparent that the greater part of the phosphate used in the United States is shipped by rail comparatively short distances, although a considerable quantity of Florida phosphate goes by sea to Harvey, La.; Alexandria, Va.; Baltimore, Md.; and Carteret, N. J. Most of the Florida hard rock is exported and is shipped from Fernandina, Jacksonville, and Tampa. Florida land pebble, on the other hand, is largely consumed in this country, and shipped by rail or boat from Tampa or vicinity.

Chief Markets Are Abroad

The chief markets for Florida high-grade hard-rock phosphate are European countries, particularly Germany, Denmark, Sweden, Norway, Netherlands, Belgium, and Spain, named about in the order of importance as consumers. Small shipments are made occasionally to England, Canada, and other countries.

Florida pebble phosphate goes to the eastern and southern United States, to western and central Europe, particularly to Spain, England, Netherlands, Ireland, and Scotland, and to Japan. Germany and Austria were heavy buyers of pebble phosphate before the war and may be again when their financial condition improves.

Tennessee and Kentucky rock is used in the central and southern United States.

The market for phosphate from the Idaho-Utah-Montana field is largely the fertilizer plants on San Francisco Bay. Lesser quantities come east to St. Louis and Chicago, and shipments of a few thousand tons have been made from Idaho to Japan and Hawaii.

Seasonal Fluctuations in Demand

In normal times shipments from the mines to domestic plants are made during the entire year, but possibly the demand for phosphate is greater in December, January, and February, for making fertilizer for spring distribution, and in July, August, and September to make the fertilizer used for fall planting. There is a uniform demand on the part of those manufacturers who make their own sulphuric acid. Those who buy their acid often discontinue receiving phosphate during the fertilizer shipping season in spring and fall. However, some of these latter receive phosphate every month.

The fertilizer manufacturers in Europe have two seasons—the spring campaign through March and April and the fall campaign from mid-August to the end of October. The times in between are used by them to manufacture and store fertilizer for the shipping seasons. Shipments of phosphate from Florida are affected accordingly to some extent, but the fluctuations are not well defined, because of the space foreign manufacturers have available for storing rock.

Probably the greatest volume of buying in Tennessee is after the fertilizer season is over—say July, August, and September. This is because then rock is in greatest supply, on account of good weather, and purchases are wisely made by the buyers when the stocks are large. In Florida, however, there is no marked seasonal buying of phosphate, and, unlike Tennessee, production is hampered in the summer months by torrential rains.

Phosphate rock is mainly calcium oxide (CaO) and phosphoric anhydride (P_2O_5). It contains also a small per cent of silica, and oxides of iron and alumina. It is sold on the basis of its content of tricalcium phosphate ($Ca_3P_2O_8$), called, also, tribasic phosphate of lime or bone phosphate of lime (B.P.L.), which constitutes 60 to 80 per cent of the rock. An increase in price is allowed for exceeding the specified percentage of tricalcium phosphate and a reduction is made for exceeding the maximum of impurities or moisture. Florida hard rock, for example, is sold on a guarantee of 77 per cent minimum tribasic phosphate of lime on a dry basis, 3 per cent maximum iron and alumina combined on dry basis, and 2½ per cent maximum moisture. Some Tennessee phosphate is sold under the following guarantee: minimum 72 per cent bone phosphate of lime; maximum 5½ per cent oxides of iron and alumina; maximum 3 per cent moisture.

Following is a table of the grades of phosphate rock as sold:

Grades of Phosphate Rock

	B.P.L., Minimum Per Cent	Iron and Alumina, Maximum Per Cent	Moisture, Maximum, Per Cent
Florida hard rock	77	3	2.5
Florida land pebble	79/77	3	2
Florida land pebble	77/76	3	3
Florida land pebble	75	3	3
Florida land pebble	75/74	3	3
Florida land pebble	70	3	3
Florida land pebble	68	3	3
Florida land pebble	68/66	3	3
Tennessee blue rock	65	3	3
Tennessee blue rock	70	3	3
Tennessee brown rock	78	4	2
Tennessee brown rock	75	5	3
Tennessee brown rock	72	5.5	3
Tennessee brown rock	70	6	3
Tennessee brown rock (ground)	70	..	..
Tennessee brown rock (ground)	65	..	..

The figures in this table mean that the rock is guaranteed to carry at least the stipulated per cent of bone phosphate of lime, and not more than the per cents indicated of iron and alumina, and moisture. As ground rock is usually applied to the soil without acidulation, iron and alumina, not being objectionable in these circumstances, are not usually guaranteed in ground rock.

There are no specifications as to hardness of rock. Tennessee phosphate rock is designated by its color as blue, brown, and white rock. The material as sold ranges in size from 10 to 12 in. lumps in Tennessee rock to ground rock that will pass a screen having 100 meshes to the linear inch. For electric furnace use, ½ to 1 in. lumps free from fines command a premium.

Both hard rock and pebble phosphate are washed to free them from fines, as most of the impurities of a phosphate deposit are in the earth, clay, or sand matrix.

Quantities handled vary from the carload of 30 or 40 tons on domestic railroads to the ship of 2,500 to 8,000 tons, and the size of orders runs from small lots like 250 tons, up to the manufacturer's requirements for a year. Most phosphate miners now refuse to contract for more than one year in advance.

Phosphate for export is shipped either in full and complete cargoes or in part-cargoes, generally about one-half capacity of the vessel. One ton of hard rock occupies one cubic yard, and by taking a half cargo of phosphate a steamer has proportionately more space left for light-weight cargo, such as cotton and naval stores.

The price is based on a certain stipulated content of tricalcium phosphate. If the phosphate content is above

the stipulated per cent, there is an allowance to the seller of a certain sum per unit for each unit or fraction thereof above the guaranteed per cent, and if the phosphate content falls below, an allowance to the buyer of a stated sum per unit for each unit that the shipment falls short of the agreement. If the iron and alumina combined is guaranteed 3 per cent with rise to 4 per cent, then an allowance is made the buyer for each fraction of a unit above 3 per cent, but the seller may not be allowed an increase in price if the iron and alumina content is below 3 per cent. One of my informants states the premium and penalty conditions as follows:

"Premiums—In standard phosphate contracts, which sellers insist on and buyers sometimes agree to, whenever the I. & A. (iron and alumina) as shown by analysis is less than the guaranteed maximum, one unit of B.P.L. is added to the analysis result for each unit of such decreased I. & A. For each unit of B.P.L. that this corrected result shows above the guarantee the seller pays a premium varying from 15c. to 25c. per unit per ton.

"Penalties—Under contracts insisted on by all buyers and agreed to by most sellers, whenever the I. & A. exceeds guarantee, two units of B.P.L. are deducted from the analysis result for each unit of such excess I. & A. For each unit that this brings the analysis result in B.P.L. below the guarantee, a penalty of 15c. to 50c. per unit per ton is exacted."

Methods of Sampling Used

As the price is based on a chemical analysis, all shipments are sampled. Sampling is done either by hand or by automatic sampling devices. One method is for the buyer to take as sample every fiftieth tub or bucket as material is delivered. Domestic phosphate is usually sold subject to sampling by seller and analysis by two commercial chemists. Export phosphate is analysed by two commercial chemists in the United States, or by two foreign chemists, the mean of the two results to be taken as the true content. Should the chemical analysis of any sample as ascertained by the chemists vary more than 1 per cent in tribasic phosphate of lime or one-half of 1 per cent in iron and alumina combined, then a part of the sample is sent to a referee chemist for analysis of the ingredient at fault, and the mean of the two results more nearly approximating each other is accepted as final. All expenses of sampling and analysis are equally divided between buyer and seller.

Phosphate rock is sold by the long ton (2,240 lb.) and ground rock by the short ton (2,000 lb.) Domestic rail shipments from the eastern fields are sold upon f.o.b. mine weights, as determined by the Southern Weighing and Inspection Bureau or railroad. The sale is on actual weight and moisture is not considered unless above the guarantee. Domestic vessel shipments are usually sold upon the weight as determined by the handling railroad or terminal company at port of loading.

Export phosphate rock is sold either upon the port of loading weights as determined by the railroad or terminal company, or upon the out-turn weight at port of discharge. Foreign buyers receive an allowance for all moisture, the phosphate being billed on a dry basis. In general, sellers undertake to specify railroad weights at point of shipment and only rarely do they agree to accept buyer's out-turn weights. Ten per cent more or less at seller's option is usually allowed as fulfillment of tonnage covered by sales contract.

As phosphate rock is sold on a dry basis or on a maximum moisture content of 3 per cent, the rock must be dried in some way and kept dry. The common method of drying is in rotary kilns using fuel oil. The old method of piling the rock on cord wood under a shed and burning it has been discontinued because wood is too scarce and expensive. Florida hard-rock miners ship the wet rock in open cars to port, where it is dried, stored, and loaded on steamers by privately owned terminal plants. Florida land pebble is dried at the mines. Several mines may unite in the use of a single drying plant. The dry land pebble is shipped in specially designed small covered railroad cars to port, or in box cars to the interior. Finely ground phosphate rock loaded in bulk is shipped in box cars lined with building paper to prevent sifting.

Wet rock is shipped in open-top, bottom-dump, coal cars or gondolas of 50 tons' capacity, and the railroads require a loading limit of 10 per cent more or less than capacity.

It is unnecessary to insure rail shipments, as the railroads are responsible for right delivery. Any loss in transit is a matter between the buyer and the railroad company. Railroads customarily pay claims promptly for loss or damage in transit.

There is no insurance by the seller in case of sales f.o.b. steamer at loading port, but if sales are made c.i.f. foreign ports, marine insurance for the value of the cargo, plus 5 or 10 per cent, and insurance for the ocean freight charge, is taken by the seller. The foreign buyer carries the insurance on phosphate sold on an f.o.b. port of loading basis.

The value of phosphate rock is computed upon the content of tricalcium phosphate and the absence of deleterious substances. For example, Florida hard rock is sold at a fixed price in dollars and cents per net dry ton, on basis of 77 per cent B.P.L. with 25c. pro rata per unit rise over 77 per cent B.P.L., or with 50c. pro rata per unit fall, down to 76 per cent B.P.L., which is guaranteed minimum. Thus, if a cargo analyzes on an average 79 per cent B.P.L., 50c. is added to the contract price per ton, or if a cargo analyzes 76.50 per cent B.P.L., 25c. is deducted from the contract price per ton.

Method and time of settlement vary. Tennessee rock is usually sold for cash by the tenth of the month on shipments made during the preceding month. Some Florida pebble phosphate is sold on a basis of 75 per cent of a pro forma invoice in cash upon presentation of shipping documents, and the balance upon receipt by the buyer of final invoice and chemists' analyses. The usual terms of settlement for export phosphate are that a credit for the approximate value of the cargo must be opened in a New York bank in favor of the shipper. The money is paid on presentation of shipping documents, including weight certificates, analyses, and invoice. Lately, in cases of sales c.i.f. European ports, payment upon arrival and on basis of European weights and analyses has been agreed upon. In such cases 6 per cent interest may or may not be charged from date of loading at American port to date of payment.

Domestic and Export Sales Agencies

Phosphate rock for domestic use is usually sold by the miner direct to the fertilizer manufacturer. Brokers handle only a small part of the output, their business being mainly between the miner and the small fertilizer mixing plants.

Before the Webb-Pomerene law was passed, competition was keen between all Florida hard-rock miners, and between the miners of hard rock and land pebble. Sales for export depended greatly upon the standing and ability of the foreign brokers or importers of phosphate. Since the passage of the Webb-Pomerene law, the miners of land pebble have formed the Florida Pebble Phosphate Export Association, and the hard-rock miners have formed the Florida Hard Rock Phosphate Export Association. These two associations have worked in unity, so far as sales are concerned, and have established agencies for the different countries, at a fixed commission per ton sold.

The export business has been at a low ebb since 1915 on account of unsettled business conditions in European countries, and especially in Germany, which has been one of the best markets for phosphate rock.

The price of phosphate rock varies with the quality, and fluctuates with the supply and demand. The quantity of dry rock in stock, the condition of crops in Europe as well as in the United States, and the ruling prices for food products affect prices. The quantity of phosphate contracted for in a single sale also has an effect on the price; the buyer of 50,000 tons to be shipped over a period of several months gets a lower unit price than the buyer of 1,000 tons for immediate delivery.

During periods of agricultural depression, financial stringency, and abundant car and labor supply, the price is depressed to the lowest point that will cover actual cost of production, without regard to the intrinsic value of the material, overhead, or fixed charges.

When agricultural conditions produce large potential buying power, when money is easy, active business in other industries creates car shortage, and labor is in heavy demand and high priced, the price of phosphate rock goes up to any figure which the fertilizer manufacturer who needs it will bid.

The following table gives the average price of phosphate rock produced in the several districts in 1910-21. These figures were obtained by dividing the money received by the number of tons sold, as reported to the U. S. Geological Survey.

Average Price per Ton of Phosphate Rock, 1910-21.

Year	Florida Hard Rock	Florida Land Pebble	South Carolina	Tennessee Kentucky	Western States
1910	$6.96	$3.43	$4.08	$3.78	$3.41
1911	6.23	3.37	3.98	3.92	3.80
1912	6.67	3.22	3.99	3.88	4.24
1913	6.10	3.20	4.03	3.93	3.60
1914	6.17	2.98	3.88	3.77	3.08
1915	5.30	2.67	3.72	3.41	3.29
1916	5.26	2.64	3.98	3.67	3.14
1917	5.93	2.65	4.14	4.14	2.77
1918	6.08	2.79	4.45	5.12	3.53
1919	8.59	3.79	5.08	6.39	4.12
1920	11.31	4.99	8.32	7.79	5.47
1921	10.27	5.44	....	6.53	4.11

Averages obtained as above do not tell the whole story, however, and may lead to erroneous conclusions. One producer suggests the following:

Average Prices of Florida Phosphate Rock f.o.b. Mines

Per Cent B.P.L.	Price per Ton
79	$7.50
75	6.00
70	4.50
68	3.75
65	3 25

Another producer states: "Prices for Florida hard rock carrying 77 per cent B.P.L. have ranged from $7.50 to $15.00 per ton f.o.b. Fernandina. It is noticeable that the highest price for the highest grade phosphate rock has not in thirty years equaled the ordinary price manufacturers will pay for dry bones of 58 per cent B.P.L."

The exportation of phosphate rock usually has little direct influence on the sale of phosphate in the United States, because the domestic market uses rock carrying 65 to 70 per cent B.P.L., whereas, the foreign demand is for rock carrying 75 per cent or more. This is because the European fertilizer manufacturers require a rock that will give them an 18 per cent soluble acid phosphate, while the domestic manufacturers want raw material giving them 14 to 16 per cent soluble acid phosphate. Practically all the Florida hard rock mined is exported. Florida land pebble carrying 75/74 per cent B.P.L. and higher is exported, but the lower grades, 72/70 per cent and lower, are nearly all sold to domestic manufacturers.

At times when foreign demand for high-grade phosphate rock is slack and Florida producers continue to operate and accumulate stock, it is possible that dumping of this high-grade rock on the domestic market may have a disastrous effect on the demand for rock of lower grade.

The quantity of phosphate rock produced in the Western States has as yet been too small to affect the domestic market, and the exports from the Pacific Coast have been only a few thousand tons.

It gives me pleasure to acknowledge my indebtedness for much of the information contained in this article to J. Carstens, with C. & J. Camp, Ocala, Florida; M. H. Grace, president, Phosphate Export Association, 2 Rector St., New York; to A. P. Hoover, of Hoover & Mason Phosphate Co., 1407 Railway Exchange, Chicago; to H. D. Ruhm, 136 Liberty St., New York; and to others who gave equally valuable data.

Following are standard forms of contracts: (1) Cost and freight form, in sellers' option, (2) free alongside form, in buyer's option, and (3) C.I.P. form:

STANDARD CONTRACT
(Cost and Freight Form)
FLORIDA HARD ROCK PHOSPHATE EXPORT ASSOCIATION

To.....

.....

QUANTITY. We have this day sold to you..... (.....) tons of 2,240 pounds each, 5% more or less, in SELLERS' option, of DRIED FLORIDA HARD ROCK PHOSPHATE.

QUALITY. With the latitude provided under the price clause of this contract, the sellers are to furnish phosphate containing 77 per cent. minimum Tribasic Phosphate of Lime on dry basis.
3 per cent. maximum Iron and Alumina combined on dry basis.
2½ per cent. maximum Moisture.

PRICE. The phosphate to be invoiced at.....Dollars ($.....), U. S. Currency, per ton of 2,240 pounds, but the following allowances to be made:
An increase in price at the rate of.....cents per ton per unit of Tribasic Phosphate of Lime in excess of 77 per cent.
A reduction in price at the rate of.....cents per ton per unit of Tribasic Phosphate of Lime below 77% down to 76% absolute minimum.
A reduction in price at the rate of.....cents per ton per unit of moisture in excess of two and one-half (2½%) per cent.
This price includes Cost of Phosphate free on board vessel and freight to ports of.....vessel's option and on basis of the United States Shipping Board Form of Freight Contract.
The Insurance is entirely at Buyer's risk from the time of delivery of Phosphate to vessel at loading port in Florida.

SHIPMENT. Shipment to be made during months of..... in about equal quantities..... in sellers' option, but a deviation either way up to 15 days not to be considered a breach of contract. Each quantity ordered shipped to be declared for a designated vessel and considered as a separate contract. Should a vessel so declared be delayed or lost before reaching the loading port or completion of cargo, then sellers are not to be held responsible for ensuing delay in fulfilling contract.
Vessel has option of carrying Cotton and/or other lawful merchandise from Atlantic or Gulf ports in United States to any ports in U. K., Continent, or Baltic, discharging same before or after the Phosphate, such cargo to be effectually separated from the Phosphate at ship's expense.

(*Continued on page* 1066)

(*Continued from page* 1065)

WEIGHTS. Official weights of the Southern Freight Inspection Bureau at loading port to be taken as the basis of settlement, and the mean moisture as determined by chemists' analyses to be deducted therefrom, such deduction not applying to freight, but only on the F. A. S. price of.....Dollars ($.....) per ton, with adjustments as provided under the price clause above.

SAMPLING. Sampling to be done by an official sampler at loading port, and to be under the supervision of either party hereto if desired. All expenses of sampling to be equally divided between buyers and sellers.

ANALYSIS. The sample to be divided into three equal portions, sealed in dry bottles or cans, one to be promptly forwarded to.....on behalf of sellers, and one to.....on behalf of buyers. The phosphate to be invoiced on the mean of the two results, unless there be a difference of more than one per cent. of Tribasic Phosphate of Lime, or one-half per cent. of Oxide of Iron and Alumina combined, in which case the third sample to be sent to Referee Chemist..... to determine the percentage of those ingredients only wherein said differences are shown, and the mean of the two nearest results to be accepted as final. Chemists to be instructed to determine the percentages of Oxide of Iron and Alumina separately. Buyers and sellers each to pay their own chemist, the cost of the third analysis, if required, to be equally divided.

PAYMENT. Buyers to open confirmed satisfactory credit in New York in favor of the members of the Florida Hard Rock Phosphate Export Association for full approximate amount of invoice at least 15 days before vessel is ready to load, 50% of which shall be payable to seller's order upon presentation of Ship's Bills of Lading, balance by sight draft with chemist's analyses, weight certificates and invoice in duplicate attached.

ARBITRATION. Any dispute arising under this contract to be settled by arbitration at Savannah, Jacksonville or Ocala, by parties accustomed to the trade, one arbitrator to be named by sellers and one by buyers; and should these two be unable to agree, they shall then choose a third, and the decision of the majority of the arbitrators shall be final.

GENERAL CONDITIONS. In the event of war, revolutions, riots, combinations of working people, strikes, fires, epidemics, cyclones, inundations, earthquakes, accidents to machinery, or any other causes, over which sellers have no control, operating to prevent or interfere with the fulfillment of this contract in whole or in part, notice of such fact shall be given by sellers to buyers, and sellers or buyers may thereupon, or within 30 days thereafter cancel the unperformed portion or portions of the contract, the fulfillment of which is or will be so affected, by giving written notice of such intention to the opposite party.

Signed in duplicate at.....this.....
day of.....19.....

.....
Sellers.

WE CONFIRM THE PURCHASE AS PER THE ABOVE CONTRACT.

.....
Buyers.

STANDARD CONTRACT
(Free Alongside Form.)

FLORIDA HARD ROCK PHOSPHATE EXPORT ASSOCIATION

To.....

.....

QUANTITY. We have this day sold to you.....
(.....) tons of 2,240 pounds each, 5% more or less, in BUYERS' option, of DRIED FLORIDA HARD ROCK PHOSPHATE.

QUALITY. With the latitude provided under the price clause of this contract, the sellers are to furnish phosphate containing 77 per cent. minimum Tribasic Phosphate of Lime on dry basis.

3 per cent. maximum Iron and Alumina combined on dry basis.

2½ per cent. maximum Moisture.

PRICE. The phosphate to be invoiced at.....Dollars ($.....), U. S. Currency, per ton of 2,240 pounds, but the following allowances to be made:

An increase in price at the rate of.....cents per ton per unit of Tribasic Phosphate of Lime in excess of 77 per cent.

A reduction in price at the rate of.....cents per ton per unit of Tribasic Phosphate of Lime below 77% down to 76% absolute minimum.

A reduction in price at the rate of.....cents per ton per unit of moisture in excess of two and one-half (2½%) per cent.

SHIPMENT. Shipment to be made during months of.....
.....
.....
in Buyer's option, but a delay up to 15 days not to be considered a breach of contract. Each quantity ordered shipped to be declared for a designated vessel and considered as a separate contract. Should a vessel so declared be delayed or lost before reaching the loading port or completion of cargo, then Sellers are not to be held responsible for ensuing delay in fulfilling the contract; and if any portion of the cargo for such vessel has been loaded on cars by Sellers under notice from Buyers, then Buyers shall assume all storage or other expenses incident to such delay, and shall within 60 days pay Sellers in full at contract price for phosphate so loaded on cars.

DELIVERY. The phosphate to be delivered free alongside buyers' vessel at Fernandina or Jacksonville, Florida, as may be indicated by sellers, vessel to be consigned to shippers' agents at the port of loading, such agents employing stevedore at current rate. At least 15 days' notice to be given sellers as to arrival of vessel. Should the railroad order any increase in railroad freights or loading charges subsequent to the signing of this contract, the same to be for account of buyers.

The phosphate to be delivered at the rate of not less than 600 tons per weather working day, Sundays and holidays excluded, commencing 24 hours after vessel is in loading berth ready to receive cargo, and written notice given to sellers' agent to that effect.

If sellers fail to deliver in accordance with this clause, then sellers are to be responsible for demurrage at a rate of .....per net register ton per running day lost. If sellers deliver in less time than is specified, then sellers are to receive despatch at the rate of..... per running day saved.

Vessel has option of carrying Cotton and/or other lawful merchandise (Phosphate excepted), from Atlantic or Gulf ports in United States to any ports in U. K., Continent, or Baltic, discharging same before or after the Phosphate, such cargo to be effectually separated from the Phosphate at ship's expense.

Sellers are not to be held responsible for failure by the Railroad to furnish necessary cars, nor delays beyond sellers' control in railroad transportation.

WEIGHTS. Official weights of the Southern Freight Inspection Bureau at loading port to be taken as the basis of settlement, and the mean moisture as determined by chemists' analyses to be deducted therefrom.

SAMPLING. Sampling to be done by an official sampler at loading port, and to be under the supervision of either party hereto if desired. All expenses of sampling to be equally divided between buyers and sellers.

ANALYSIS. The sample to be divided into three equal portions, sealed in dry bottles or cans, one to be promptly forwarded to.....on behalf of sellers, and one to.....on behalf of buyers. The phosphate to be invoiced on the mean of the two results, unless there be a difference of more than one per cent. of Tribasic Phosphate of Lime, or one-half per cent. of Oxide of Iron and Alumina combined, in which case the third sample to be sent to Referee Chemist..... to determine the percentage of those ingredients only wherein said differences are shown, and the mean of the two nearest results to be accepted as final. Chemists to be instructed to determine the percentages of Oxide of Iron and Alumina separately. Buyers and sellers each to pay their own chemist, the cost of the third analysis, if required, to be equally divided.

PAYMENT. Buyers to open confirmed satisfactory credit in New York in favor of the members of the Florida Hard Rock Phosphate Export Association for full approximate amount of invoice at least 15 days before vessel is ready to load, payment under such credit to be made against Ship's Bills of Lading, certificates of weights and analyses, and invoice in duplicate.

ARBITRATION. Any dispute arising under this contract to be settled by arbitration at Savannah, Jacksonville or Ocala, by parties accustomed to the trade, one arbitrator to be named by sellers and one by buyers; and should these two be unable to agree, they shall then choose a third, and the decision of the majority of the arbitrators shall be final.

GENERAL CONDITIONS. In the event of war, revolutions, riots, combinations of working people, strikes, fires, epidemics, cyclones, inundations, earthquakes, accidents to machinery, or any other causes, over which sellers have no control, operating to prevent or interfere with the fulfillment of this contract in whole or in part, notice of such fact shall be given by sellers to buyers, and sellers or buyers may thereupon, or within 30 days thereafter cancel the unperformed portion or portions of the contract, the fulfillment of which is or will be so affected, by giving written notice of such intention to the opposite party.

Signed in duplicate at.....this.....
day of.....19.....

.....
Sellers.

WE CONFIRM THE PURCHASE AS PER THE ABOVE CONTRACT.

.....
Buyers.

Contract No.....
Contract Code Word.....

EXPORT CONTRACT FOR FLORIDA LAND PEBBLE PHOSPHATE
(C. I. F. Form.)
Code Word "Pebamrif"

THIS AGREEMENT, made this.....day of .....19.... between.....
with General Offices at.....
hereinafter termed "Seller," and.....,
with office at.....
hereinafter termed "Buyer."

WITNESSETH: That the Seller agrees to sell and does hereby sell and the Buyer agrees to purchase and does hereby purchase, upon the conditions hereinafter named, the following quantities of Dried Florida Land Pebble Phosphate,

Quantity and Description: The quantity is about (i.e. 10% more or less in Seller's option on each shipment)..... tons of DRIED FLORIDA LAND PEBBLE PHOSPHATE, product of the mines in Florida of the.....

Quality: The basis upon which the Phosphate is sold is..... .....per cent. (.....%) Tribasic Phosphate of Lime with allowance for a fall to.....per cent (.....%) Tribasic Phosphate of Lime absolute minimum guaranteed, as noted below, calculated on a dry basis, the Phosphate being dried at 100° Centigrade. Should the Oxides of Iron and Alumina (exclusive of any Pyrites) exceed three per cent. (3%) combined, Buyer is to be allowed the contract value of two units of Tribasic Phosphate of Lime to one unit of Oxides of Iron and Alumina, over three per cent. (3%), fractions in proportion, up to four per cent. (4%) maximum.

Price, Place and Mode of Delivery: The price shall be..... .....dollars .....cents ($.....) U. S. Gold per ton of 2,240 pounds. The price which is based on.....per cent (.....%) Tribasic Phosphate of Lime shall rise at the rate of.....U. S. cents per unit per ton for any excess over.....per cent. (.....%) (fractions in proportion), or shall fall at the rate of.....U. S. cents per unit per ton for any deficiency below.....per cent. (.....%) (fractions in proportion), down to..... .....per cent. (.....%) minimum guar-

anteed, cost, freight and insurance (f.p.a.) to.....
.....
or as near thereto as the ship can safely get, always afloat, lighterage (if any) being for Buyer's account; or, at Seller's option, transhipment in whole or in part from another Port. Vessel to have the privilege of taking additional Phosphate, Cotton and/or other lawful cargo, at and for any ports in any order, such cargo to be effectually separated from the Phosphate sold hereunder.

The Phosphate to be invoiced on the dry basis (100° Cent.) and the mean moisture found in the moisture sample by drying at 100° Cent. to be deducted from the weight.

The Phosphate sold and delivered under this contract shall be shipped only to.....

Period of Shipment: Shipment to be made during.....
.....
(in Seller's option) but a deviation either way up to fifteen (15) days shall not constitute breach of contract.

Payment: Net cash in New York against shipping documents, consisting of Bills of Lading, Insurance Policy and Certificates of weight and analysis, for the full value of the Phosphate shipped, less ocean freight, Buyer hereby undertaking to open not less than seven days in advance of each shipment a Confirmed Bank Credit in New York in favor of Seller, the bank selected to be subject to Seller's approval.

Buyer to pay freight for Seller's account in accordance with Seller's Charter Party, without charge and free of commission, any in Charter being for Seller's benefit; also to act in interest of Seller, and if required, to take any powers of Charter to recover from ship for damage. Seller hereby undertakes to furnish Buyer with a copy of the Charter Party not less than seven days in advance of arrival of vessel at port of discharge.

Weighing, Sampling and Analysis: Railroad or Terminal Company's weights at port of shipment to be accepted as basis of settlement.

Samples taken at port of shipment by the Railroad or Terminal Company's representative to be taken as basis of settlement, and the cost of such sampling shall be borne equally by Seller and Buyer. The sampling may be under the supervision of Seller's and/or Buyer's representatives if desired. All samples shall be sent by the Railroad or Terminal Company's representative to the Chemists hereinafter specified.

Analyses of these samples are to be made by Wiley & Co., Baltimore, Md., and Ocala Laboratory, Ocala, Florida, the mean of whose results calculated on the dry basis shall form basis of settlement unless there be a difference between their results of one unit or more in Tribasic Phosphate of Lime, or of half a unit or more in Oxide of Iron and Alumina, in which case a third sample (part of the original sample) shall be sent to Gascoyne & Company, Baltimore, Maryland, for analysis of the ingredient concerned, and the mean of the two nearest results calculated on the dry basis shall be taken as final.

Cost of all analyses to be equally borne by Seller and Buyer.

Delivery: Phosphate to be taken from ship's tackle by Buyer at his expense and risk, and according to the terms of Seller's Charter Party; and Buyer to pay any demurrage arising from his failure to do so.

Force Majeure: Seller shall not be liable for delay or failure in delivery due to war or effects of war, revolution, civil commotion, strikes or lockouts of workmen or railwaymen, breakdown on or stoppage of railways, shortage of cars, interruption, stoppage or shortage of Seller's fuel supply now or hereafter under contract, stoppage or destruction of goods in transit, yellow fever or other epidemic, fire, cyclones, tempest, inundations, earthquakes, unavoidable accidents to machinery, boilers, or other unavoidable hindrances in mining, transporting or loading the Phosphate, restraints of established authorities, or to any other causes or hindrances over which Seller has no control, and deliveries may be suspended by Seller (due notice being given to Buyer) until such impediments shall have been removed or overcome; provided always that if such impediment shall have continued for a period of sixty (60) days beyond the original shipping period for the quantity concerned, such non-shipped quantity may then be cancelled by either Seller or Buyer, in which event notice of such cancelment must be despatched by cable and confirmed by registered post within fifteen (15) days after the termination of the period of sixty (60) days' extension above referred to.

Should any vessel named by the Seller for a specific shipment be unavoidably delayed or lost before reaching point of loading or completion of cargo such shipment shall be postponed until the delayed vessel, or in the event of loss until a substitute for lost vessel which Seller undertakes to furnish and which when chartered shall be in a position to load within sixty (60) days of the original vessel's loss, arrives at point of loading, provided always that in case such delay shall exceed eighty (80) days from the original contract loading date such shipment may then be cancelled by either Seller or Buyer, and in that event the quantity deliverable under this contract shall be diminished accordingly. Notice of such cancelment must be despatched by cable and confirmed by registered post.

General Conditions: Each shipment to stand as a separate contract.

This contract to be subject to all conditions of Seller's Charter Party.

In the event that any tax, duty, or other Governmental charge of any kind upon the production and/or sale and/or shipment of Florida Land Pebble Phosphate be imposed by the Federal or State Authorities of the United States, such charges shall be paid by Buyer as an addition to the contract price, and the Bank Credit shall be increased accordingly. Due notice shall be sent by Seller of the imposition of such charge, and Buyer may within fifteen (15) days of receipt of such notice notify Seller that he is unwilling to pay such charge. If Buyer exercises this right, then within fifteen (15) days of receipt of Buyer's notification the Seller may on giving notice to Buyer elect (1) to ship the next delivery without adding such charge, or (2) to cancel the next delivery to be made hereunder. In the event of Seller electing to ship as above or to cancel the next delivery, the Seller shall before each succeeding delivery becomes due give notice to Buyer to elect whether he (the Buyer) will pay such charge or not, and failing notice of election from the Buyer within fifteen (15) days that he will pay the same, the Seller shall have the same right of electing to ship the then next delivery without adding such charge or to cancel the then next delivery as in the case of the first refusal.

This contract is to be construed and the respective rights of the parties hereto are to be determined according to the laws of the State of New York (U. S. A.).

Arbitration: All disputed questions which may arise and occasion controversy relating to this contract shall be submitted to arbitration, under the then existing rules of the Committee on Arbitration of the Chamber of Commerce of the State of New York. In the event of the failure of the parties to agree upon arbitrators within thirty (30) days after either party has in writing requested arbitration, the matter in dispute shall be submitted to the Committee on Arbitration of the Chamber of Commerce of the State of New York which is hereby authorized to select three (3) impartial persons at least one of whom shall be from the "Official List" of Arbitrators and shall be Chairman, and the award of the majority of the Arbitrators shall be final and binding upon both parties.

SELLER.
.....

BUYER:
.....

Statistics Show Marked Improvement in Bauxite Industry

The production of bauxite in the United States in 1922 was 309,600 long tons, valued at $1,935,800, according to the U. S. Geological Survey. These figures show an increase of more than 100 per cent in quantity and of more than $1,000,000 in value over those for 1921. The Arkansas field produced 266,799 long tons, more than double the output in 1921, but still less than half of its yearly maximum. The eastern fields, in Alabama, Georgia, and Tennessee, produced 42,810 long tons, nearly four times as much as in 1921 and about the maximum output from those fields. Georgia leads, with an output of 30,417 long tons.

Bauxite Produced and Consumed in the United States 1921 and 1922

(In Long Tons)

	Domestic Production	Imports	Exports (a)	Apparent Consumption
1921	139,550	27,587	5,942	161,195
1922	309,600	22,219	19,617	312,202

(a) Includes bauxite concentrates.

Domestic Bauxite Consumed by Different Industries 1921 and 1922

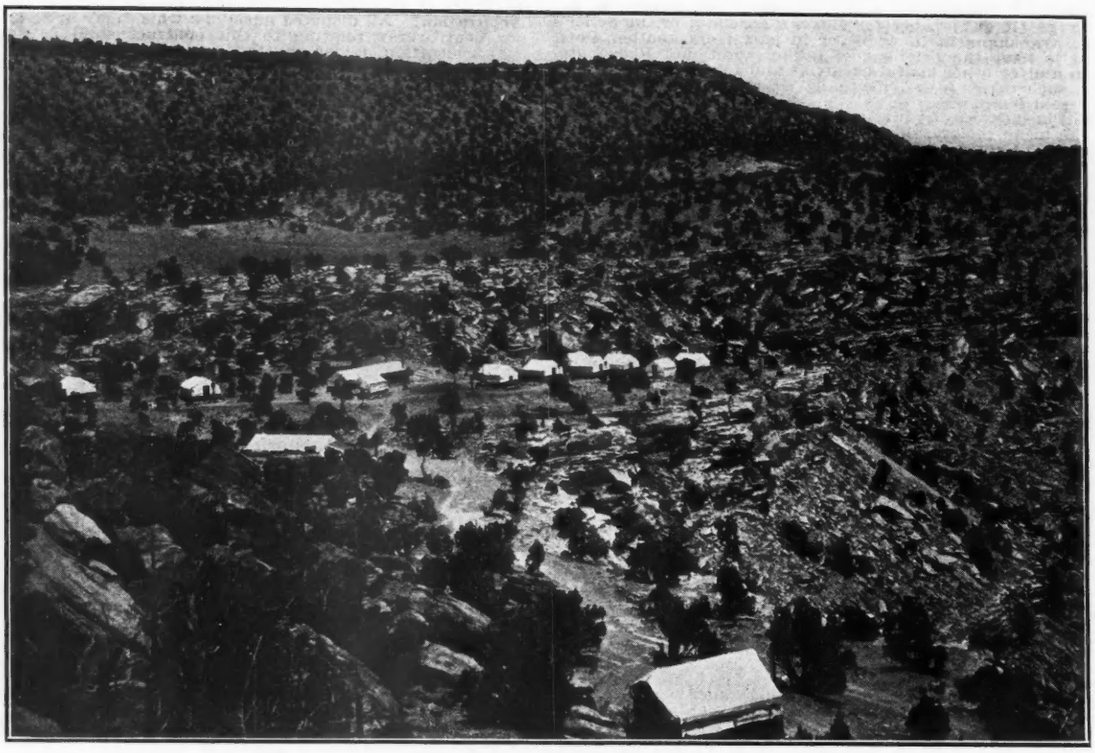
(In Long Tons)

	Aluminum	Chemical	Abrasive and Refractory	Total
1921	91,660	41,030	6,860	139,550
1922	211,550	78,550	19,500	309,600

Rich Congo Radium Ores Shipped to Belgium for Treatment

In an article first appearing in the *Buluwayo Chronicle*, G. C. Norris states that there recently arrived in Belgium from the Congo about 60 tons of pitchblende ore carrying 50 per cent of uranium oxide, from which about 8 g. of radium could be extracted. It is this exceeding richness of the Congo ores and the consequent cheaper extraction costs which have led to lowering the price of radium and shutting down the American plants. There is a tendency for interested operators in America to believe that the extremely rich Katanga ore must be from a pocket, and that the values will not be maintained. However, in July of last year the technical staff of the Radium Company of Colorado proceeded to Belgium to work out the details of the new radium enterprise, and a joint corporation has been formed by the American company with the Société Générale du Radium to market radium throughout the world. An extraction plant to treat the Congo ore has been erected at Oelen, in Belgium.

It is further stated that £15 per milligram is expected to be the standard price of the radium content of the chloride or bromide sold, until the grade of ore from the Congo falls off and extraction costs increase.



Dolores—a typical carnotite mining camp in Colorado

Sorting, Hauling, and Sampling Carnotite Ore

The Development of More Efficient Methods in Southwestern Colorado—Motor Trucks Displace Burros—Mechanical Sampling

BY H. S. WORCESTER
Mining Engineer, Telluride, Colo.

THE carnotite-producing section of Colorado is situated in the western end of Mesa, Montrose, San Miguel and Dolores counties. By far the most productive district is in the western end of Montrose County. This is known as the Paradox district, and embraces the country adjacent to the East and West Paradox valleys and the lower San Miguel River. The area is arid and very rough. The streams, which periodically have heavy flows, have cut deep canyons through the sedimentary beds. Wherever the sandstones or conglomerates are well cemented, high cliffs have been formed by erosion along the streams. These high cliffs and the narrow deep canyons have caused the naming of the region as the "Rim Rock" country. The sparsely settled condition, the lack of water, and the scattered groups of small orebodies have combined to centralize mining about small camps, which are usually near a spring or other source of water. The ore belt is from fifty to ninety miles from the Rio Grande Southern R.R. at Placerville, Colo. This, the principal shipping point, is about twenty-two hours from Denver when the trains are on schedule. Roads, or rather what were originally trails and have become roads by the added improvements, are the means by which the various camps are reached from Placerville. The principal road has lately been greatly improved, and consequently is fair for traffic except for some heavy grades.

The geologic section showing the strata near the Dolores camp gives a good illustration of the structure that is most interesting from the standpoint of the miner. The upper portion of the Dakota beds and all of the Mancos have been eroded away at this point, and the beds below, including the Cutler, Pennsylvanian, and the Pre-Cambrian granite which underlies all, do not outcrop at this point. The major quantity of carnotite ore has come from a bed of the McElmo formation about from 275 to 375 ft. above its base. This bed has been much faulted and tipped, so that it is seldom in a horizontal position. The ore is found in horizontal lenticular bodies, in so-called logs, in irregular masses, and as thin beds covering fairly large areas. The ore without faulting may raise or lower as much as 14 ft. vertically, within a comparatively narrow horizontal range, and still remain in the same bed. Again, two or more bodies may occur vertically in the same bed with only a layer of sandstone or shale between them.

The original orebodies mined were the high-grade deposits which erosion had exposed at the rims or near the surface. As these were mined out others had to be found, and first recourse was had to short tunnels

and openings from the rims. These proved inefficient and expensive. To develop the amount required various means of prospecting back of the rims were adopted. Jackhammer drilling with hollow steel up to 32 ft. long was used. The cuttings blown from the hole when ore was struck were saved for sample. Then core drills, first of the shot-drill type, and later of the gasoline-engine-driven pattern of diamond drill mounted on skids, were adopted for this search. This type of prospecting resulted in finding orebodies which were mined from slopes and from the longer tunnels as the mining is now done. Most of the development of ore-handling methods has taken place since 1910, as prior to that time the operations were carried on in a desultory fashion.

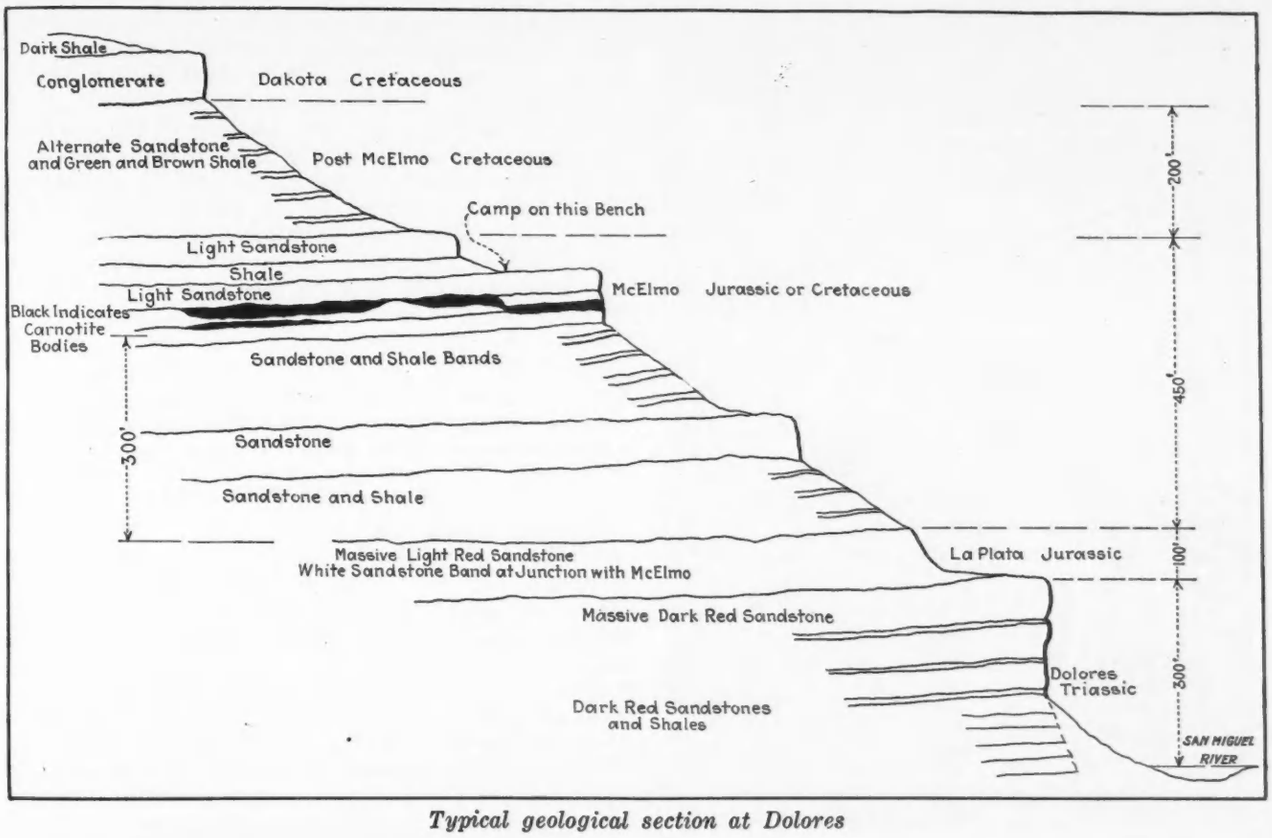
Ore handling, commencing at the point where the material was brought to the surface, was originally a simple operation. A smooth area of sandstone near the mine opening was selected and the ore as mined was dumped on this. Sorters, sitting on powder boxes or kneeling around the heaps, sorted and cobbed out the waste and low-grade from the ore to be sacked. This was shoveled into sacks. Grab samples from the sacks in a lot were combined and cut down for assay. The sample between each quartering was broken by hand. The lot thus sampled was treated separately and weighed and handled as a unit from that time.

Sorting Methods Improved

With the development of greater tonnages, this method of sorting gave place to the use of storage bins for the crude ore, sorting tables placed below them, and storage platforms for the sacked ore. When the ore was later handled in bulk the ore-storage platforms gave way to sorted-ore storage bins. As the first orebodies mined were the larger and better grade, and the mining was done mostly by hand, the sorted ore averaged about 50 per cent of the ore mined. The increase from a few tons to thousands of tons mined per year and the resulting availability of much lower grade and thinner orebodies, with the application of machine drilling, has made the sorting problem more important. The ore saved from the total rock broken does not now average more than from 5 to 20 per cent. This of course includes rock broken in development, of which there was much less done in earlier mining. For local milling in the last year the operation of sacking has been discontinued; it has been succeeded by loading sorted ore in bulk for transportation to the mill. Arrangements have been made to handle this efficiently at the plant.

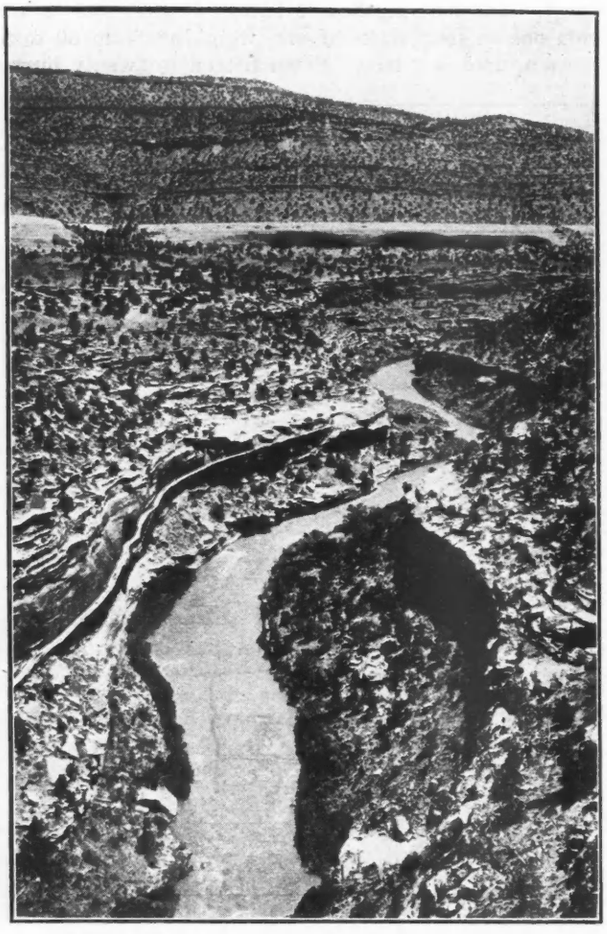
Transportation of the ore has at all times been a serious problem, because the mines were difficult of access. The first method of transportation was to load from one to four sacks of ore, weighing from 60 to 90 lb. each, upon a burro. From fifteen to twenty burros were used in a pack string. A man called a burro packer was in charge. The number of sacks to the burro depended on the distance and type of country over which the pack was made. Four sacks were loaded, averaging 70 to 75 lb., on one pack where the distance was about a mile and all down hill. On this particular pack three trips were made per day, and the cost of operating a string was about $10 per day.

On long packs the loading dropped to two sacks to the burro. The burros, despite their hardiness and resistance to rough treatment, must still, when being worked steadily, be carefully fed and watched. The first stage in transportation of the ore from the mine was by steep zigzag trails to the roads in the valleys. This was always accomplished with burros. In the earlier mining ore was hauled by wagons from the



Typical geological section at Dolores

foot of the trail to Placerville, and shipped thence to the reduction works. Later roads were built to the principal camps, so that burro packing is now practiced only from a few outlying camps. The hauling by wagons was generally by contract rate. The teamsters usually use a wagon and trailer, with four to six horses. They haul a total net load varying from 1,000 to 4,000 lb. per horse. The smaller figure is used where the haul is bad and the larger one where the haul requires little up-hill pull. The distance made with load was from 16 miles per day where roads were rough, to 22 to 25 where roads were good. When light, better speed was made. One teamster drove eight horses and used a wagon and two trail wagons to take a net load of 21,000 lb. 63 miles. This is regarded as a record for one teamster over these roads.



Lower San Miguel River in the carnotite region

Ore Formerly Sacked for Hauling

Wagons have been almost replaced by motor trucks except on short hauls or over roads too rough for the truck to travel economically. This replacement of wagons is because of the greater ton-mileage which can be made per man per day with the truck. The trucks vary from one-ton to five-ton capacity, and are generally overloaded. The mileage made under fair conditions varies from 50 to 80 or 90 per day. Under bad road conditions this drops off markedly, and a week may be required to get to Placerville with a light load.

At the principal concentrating mill in the district, the ore formerly was received in sacks, which were dumped by hand into the coarse-ore bins. As tonnages increased it was seen that this would be uneconomical, and steps were taken to decrease the cost of handling both at the mine and at the mill. At the mines, chutes were placed on bins for sorted ore, so that the ore could be loaded to the wagons or trucks by gravity. Then at the mill, after weighing, the wagons or trucks were driven onto a dumping platform 20 ft. long by 9 ft. wide. This swings on a hingled shaft, supporting the platform, so that one end may be tipped down and the other up to an angle of 45 deg. It is controlled by a rack hinged to one end of the platform and in mesh with a pinion on a worm gear shaft, which in turn is driven or held by a worm, driven by a 3-hp. motor.

A Novel Wagon Dumper

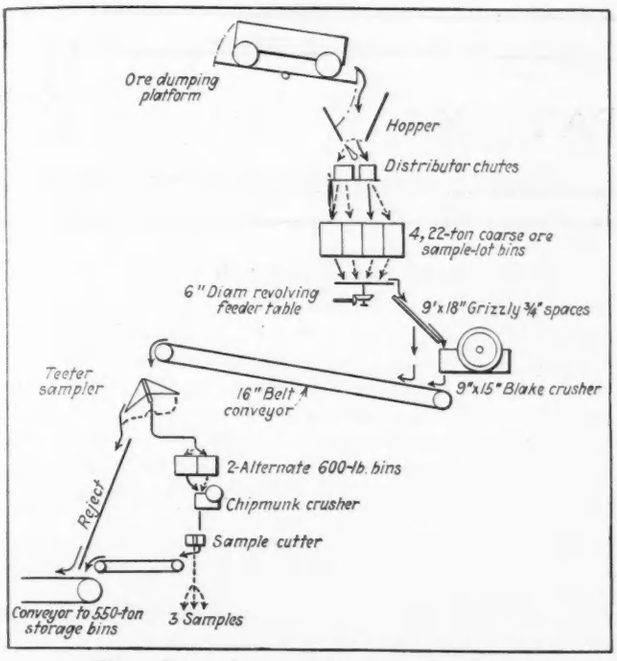
The loads are fastened by chain and cable to the platform, the chain being hooked around the rear axles. Then wagons or trucks are tipped to a sufficient angle to discharge their loads through the end. The contents are dropped through a hopper and thence through distributor chutes to any one of four bins below. Any lot can be dropped separately by simply opening the gate in the bottom of the bin to which it was dumped and allowing it to discharge onto the feeder for the sampling-plant crusher. The capacity of the dumping platform is a gross load of 20,000 lb. When in operation a load of 10,000 lb. net weight may be dumped in about five minutes from the time it is run on to the time it is run off. This arrangement was developed for a particular condition and works well with any of the wagons or trucks of the section.

The product from the mill is a concentrate which is crushed to different degrees of fineness and sacked. Sacks weigh from 80 to 130 lb., depending upon the kind of material. The sacks are loaded on wagons or trucks and hauled to Placerville for shipment to reduction works in the East.

Sampling Methods Improved

The ore is sandy and commonly has a moisture content of from 4 to 6 per cent. This is sufficient to keep down the dust when crushing freshly mined rock. The ore dries rapidly, so that when sacked ore is being crushed means are employed to provide for control of the dust.

The values are rather evenly distributed through the ore, so that, compared with sampling gold or silver ores, the sampling may safely be more simple. The ore offers some difficulty in crushing, not because of hardness but because it transmits no strain. To get the capacity tonnage out of standard jaw crushers it is necessary to decrease the nip angle of the jaws. This may be done by a wedge plate behind the movable jaw plate. In this mill the ore is dropped to a revolving feeder table from the sampler storage bins. It is plowed off by a stationary adjustable plow, which discharges to a fixed grizzly spaced ¾ in. The oversize feeds by gravity into a 9 by 15-in. Blake crusher, and the product, with the undersize from the grizzly, is fed to a 16-in. belt conveyor which discharges to a teeter sampler. The reject from this passes by chute and a conveyor to the crushed-ore storage bins. The cut passes by chute to small bins over a small crusher, which crushes it to ⅜ in. or finer. This product is cut again and the reject passes by a small conveyor to the main conveyor and thence to the bins. The sample cut is split by hand to three parts, (1) for the samplers



Flow sheet of a carnotite sampling plant

record. (2) for the seller in case of custom ore, and (3) for the mill laboratory. From the storage bins the ore passes to the dry pan, which is a crusher with mullers similar to a Chile mill, except that the muller shaft stands still and the pan revolves under the mullers. The product from this is ½ in. and finer. The crushed ore goes to storage bins, from which it is fed by screws to the mill-feed conveyor. The first screening comes at this point, the feed going to Newago screens with 10-mesh wire screens. The oversize goes to rolls operating in closed circuit with another Newago screen. From here the feed goes into the mill proper, where concentrating is accomplished.

The salient points in the development of the practice may be summarized as follows: The ore sorting has become much more economical, one sorter handling ten to fifteen tons of rock, as against the maximum under the old system of five tons per day. The change in transportation from burros to trucks, with an attendant minimum drop in transportation costs of 25c. per ton-mile. The change from hand to mechanical sampling, with the avoidance of the excessive costs and the inaccuracies that usually creep in to hand sampling as a consequence of the human element.

Production of Graphite Increased in 1922

The sales of crystalline graphite in the United States in 1922 amounted to 1,849,776 lb., valued at $85,242. This was an increase of 56 per cent in quantity as compared with 1921, according to a statement given out by the Geological Survey. The average value of the graphite per pound was 4.6c. in 1922, which was 1.8c. less than in 1921.

The quantity of amorphous graphite sold was 2,200 short tons, which was an increase of 19 per cent in comparison with 1921. This quantity represents the sales of only two companies.

The Acheson Graphite Co. at Niagara Falls, N. Y., reported sales of artificial graphite amounting to 13,031,926 lb. in 1922, an increase of 121 per cent as compared with 1921.

Diamonds From Arkansas

Nearly 6,000 diamonds have been found in diamond mines in Arkansas, and some stones have been picked up in other states. The diamond fields of Arkansas are in Scott County, where a valuable diamond was first found in 1906 by John Huddleston, a farmer. The mule he was riding happened to kick up a stone of unusual brilliance, which caught his eye. He dismounted, picked up the stone and put it in his pocket, and a few days later the performance was repeated. The stones were sent to Tiffany, of New York, whose expert said "diamonds," and soon afterward Mr. Huddleston is said to have sold his 40-acre farm for $36,000. Though the diamond field of Arkansas has never achieved greatness, it has yielded a considerable number of fine stones, the largest weighing 21¼ carats. Another stone weighed 17.86 carats. Many of the Arkansas stones are as fine as any found elsewhere, and, according to George F. Kunz, of Tiffany's, they include a large proportion of white stones, most of them of a high grade in color and brilliancy and freedom from flaws. Dr. Kunz further states, in describing several of the yellow, brown, and white stones from Arkansas, that "these are absolutely perfect and are equal to the finest stones found at the Jagersfontein mine or that were ever found in India."

A few of the Arkansas diamonds, it is said, have sold for as high as $600 a carat. Most of them, however, are uncut and have been placed in private and museum collections. Diamonds do not occur in clusters, nor are they gathered together in the volcanic "pipes" of mother lodes in which they are found. The average recovery in the African diamond mines is about one carat to two tons of ore, and the average recovery in the Arkansas mines has been about one carat to eight tons of ore.

The diamond deposits of Arkansas are described in a report recently issued by the Geological Survey, as Bulletin 735-I, entitled "Diamond-Bearing Peridotites in Pike County, Arkansas," by Hugh D. Miser and Clarence S. Ross. The report includes a description of the diamonds and the inclosing rocks, compares the deposits with those in the diamond fields of South Africa, and contains geologic maps and pictures of the mines and the diamonds.

Oil-Bearing Sands of Colorado and Wyoming

Nearly every thick bed of sandstone in the great Cretaceous system of the West seems to contain oil at some locality, but the exact number of these beds, the region in which each produces oil, and the identity and the stratigraphic position of each have not yet been fully determined.

A recent brief report issued as Bulletin 751-A of the Geological Survey, entitled "Continuity of Some Oil-Bearing Sands of Colorado and Wyoming," by W. T. Lee, deals with the correlation of rocks in the lower part of the Cretaceous system in Colorado and Wyoming, and with the bearing of this correlation on the discovery of oil and gas. These beds have heretofore been known by diverse names, and in this report an attempt is made to show their continuity through areas where they have been thus differently named. This identification of the beds furnishes to oil men a better basis for study and drilling. For example, the knowledge that a bed of sandstone which is known in some regions as the Dakota is in others known as the Muddy sand and that it overlies two other beds of sandstone that may be oil bearing is of obvious practical value to the oil driller.

CONSULTATION

The Use of Magnetite in Iron Blast Furnaces

"I shall be greatly obliged if you will tell me how many iron blast furnaces in the United States are dependent wholly upon magnetite and are smelting it as such?

"How many are subjecting magnetite to preparatory treatment such as sintering, briquetting, and nodulizing? Which has the greatest favor?

"Some years ago articles on sintering were published in the *Transactions* of the A.I.M.E., and while comparatively new practice the results were so good that argument was advanced in favor of sintering the whole charge."

We have no information as to how many blast furnaces are wholly dependent upon magnetite. It is doubtful if any furnace—unless it be one of the few small charcoal furnaces still existing—uses magnetite exclusively.

Less than 5 per cent of the country's iron-ore production is magnetite, and nearly all of this is mined in eastern Pennsylvania and western New Jersey. The largest consumer is the Bethlehem Steel Co., followed by the Replogle interests in New Jersey. Owing to the fact that most blast-furnace operators do not like to smelt the magnetite, because of its compactness and difficulty of reduction, other more easily smelted ores are always added to the furnace charge.

Sintering of fine ores and flue dusts is becoming increasingly popular. The machine ordinarily used is the familiar Dwight-Lloyd sinterer. The most recent project in the Lake Superior iron regions consists of mining a low-grade magnetite ore, concentrating it, and then sintering the fine concentrate. This gives a porous clinker and the ore is largely changed to hematite. The process has a bright future.

A Siphoning Limit

"Will you kindly inform me in regard to the following matter: How deep can I siphon water from a shaft in a mine? Is there a limit? I am enclosing a sketch of my proposed method of installing a siphon pump system. What kind of a pipe should I use? About 25 gal. per hour is to be removed."

[The sketch referred to is a cross section of a mountain containing an inclined vein and shaft about 500 ft. deep dipping about 70 deg. The diagram shows a pipe laid down the shaft and down the side of the mountain, providing a typical siphon arrangement.]

The scheme will not work. The vertical height to which it is possible to siphon water is close to 30 ft. at sea level, a height which decreases with altitude. It is out of the question to attempt using a siphon for several hundred feet. The only solution is to use a pump in the bottom of the mine to drain it. There is a mine in Oregon, and others may use similar means, which pumps from the bottom of a mine about 600 ft. deep. It sends the mine water as it issues from the main adit to a power flume having a head of about 1,500 ft. This head is ample to provide energy enough to drive the mine pump, so that the mine may be said to drain itself.

The Work of the Research Corporation

A misconception, held by a subscriber and possibly others, of the purpose and work of the Research Corporation, is removed in the following correspondence, which took place between a subscriber, Dr. F. G. Cottrell, Dr. A. A. Hamerschlag, president of the Research Corporation, New York City, and the *Journal-Press*. It brings out some interesting facts shedding light upon the conduct of the Research Corporation's affairs. The subscriber wrote:

"Can you tell me where I can obtain a list of the patents under which the Cottrell Process controls the electric precipitation of dust and fume?

"I have a dim recollection to the effect that there was considerable litigation regarding these patents and that the whole matter was treated in some detail at one time in your columns, and those of your associate publications."

To which the *Journal-Press* replied as follows:

"We think you are in error in your recollection that there has been litigation over the Cottrell patents for fume precipitation. So far as we know these have never been questioned. They have never been commercialized in the ordinary sense of the word, as the companies which control the process, the Research Corporation in the East, and the Western Precipitation in the West, are prevented by their articles of incorporation from ever paying any dividends. Instead, any profits go to additional research work. Dr. Cottrell has, therefore, never reaped any large return from his inventions, outside of a retaining fee as consulting engineer for the operating companies, probably. This method of turning over his patents for the public good has been commented on favorably many times.

"We have no list of the Cottrell patents in this office, but I would think that the Research Corporation, whose office is at 25 West 43d St., New York City, would have no objection to furnishing you a list of their patents, under the circumstances."

Thereupon the subscriber wrote the following comment:

"I desire to thank you for your kind letter. The writer was evidently mistaken in his recollection that there had been litigation regarding these patents. Apparently you are under the impression that the Research Corporation and the Western Precipitation Co. are not realizing any profit out of these patents and neither is Mr. Cottrell or anybody else. If this is the case it is remarkable and worthy of note, if not of commendation. The writer personally does not believe that philanthropy in business ever has any lasting good results. A fair price paid for a fair value received is, in my opinion, a much better foundation for all business.

"I have been advised from sources which are ordinarily reliable that the companies mentioned are owned or at least sentimentally controlled by the General Electric Co. and the Westinghouse Electric & Manufacturing Co., and while they make no profit by the exploitation of the Cottrell patents in the form of royalties, the arrangement has permitted the parent companies to develop and patent and charge what they please for all the essential apparatus required for putting the Cottrell invention into effect. This information may be totally incorrect, and if so it does great injustice to all those interested. But if it is a fact, it indicates a little lack of sincerity in the philanthropic pose of the two companies above mentioned.

"Personally, the writer has no interest in the matter,

and I am perfectly willing to see all four companies named make all the money they can, and I am even willing to contribute toward this by purchasing their apparatus, for it is unquestionably of merit. I am interested in knowing, however, whether I am mentally doing the Research Corporation and its associates an injustice."

In an effort to bring the testimony of the principals to bear upon the issue, the *Journal-Press* wrote to both Dr. Cottrell and Dr. Hamerschlag for additional information. Dr. Cottrell's illuminating letter follows:

"I am enclosing herewith copies of an article entitled 'The Research Corporation, an Experiment in Public Administration of Patent Rights,' which I prepared in 1912,[1] describing the general situation in detail, on the last page but one of which you will find the relations of the companies more specifically dealt with. Since my retirement from the Precipitation companies in 1911 and the foundation of the Research Corporation in 1912, I have never been under salary or retained as a paid consultant by any of these organizations, though I have co-operated in a friendly way and offered advice when called upon. The only interest that I have had, or have at present, in the precipitation patents is in certain of the foreign rights from which I receive a certain percentage of net royalties.

"You will notice that although the Research Corporation is essentially a public institution, in that its stockholders and directors can never, as such, receive any profits or payments from the business it conducts, the Western and International Precipitation Companies are purely commercial enterprises, though they have co-operated very generously and effectively with the Research Corporation in all matters concerning the technical development of the art. Recently, to facilitate the handling of business, and this in many border-line fields, as, for example, where a company may have operating plants in the geographic fields of both the Research Corporation and the Precipitation Companies, the Precipitation Companies have established an Eastern representative with the same offices as the Research Corporation, in 43d St. This is purely a matter of convenience and in no way affects the fundamental character or relationships of the organizations.

With reference to relations of the Research Corporation to such interests as the General Electric and the Westinghouse Electric Manufacturing companies, the directors and officials of the Research Corporation have been very careful throughout to keep the corporation entirely free from control or domination by any particular set of interests, either through business agreement, interlocking directorates, or any other of the many devices by which such control or domination is ordinarily effected in business today. The corporation has attempted to maintain friendly and helpful relations with any and all business concerns working in related fields where the corporation could add to the efficiency and better service.

"Quite recently Dr. A. A. Hamerschlag, formerly president of the Carnegie Institute of Technology, Pittsburgh, has accepted the presidency of the Research Corporation, and is spending a good portion of his time in New York directing the conduct of its affairs. If you or your reader are interested in going further into the matter I would suggest that you get directly in communication with him. He is vigorously taking up some new and interesting matters of policy in regard to the corporation.

"My own interest at present in this general subject centers more particularly on the question of just how government laboratories, and the Fixed Nitrogen Research Laboratory in particular, can best handle the various aspects of patent questions with which they have to deal. The subject is an extremely important one, in which I rather look for constructive development in the future.

"One of the chief objects which the founders of the Research Corporation had in mind was to supply through it a certain amount of experimental data on the actual administration of patents, at least in a quasi-public way, which might aid in further studies of these subjects by responsible government officials, who will inevitably be called upon sooner or later to make definite decisions along the lines indicated in President Harding's Executive Order, 3721 of Aug. 9, 1922, to meet the great complexities of our industrial and administrative systems today.

"Trusting that this will give you at least some of the information you wish and put you in the way of getting anything further that is needed, I am,

"Yours sincerely,

"F. G. COTTRELL,

"Director, Fixed Nitrogen Research Laboratory."

Dr. Hamerschlag has contributed further to the discussion, pointing out the exceedingly altruistic attitude of the Research Corporation. His remarks follow:

"Mr. F. E. Wormser, Assistant Editor,
Engineering and Mining Journal-Press,
McGraw-Hill Company, 10th Ave. at 36th St.,
New York City.

"DEAR SIR:

"A copy of the correspondence between you and Dr. Frederick G. Cottrell concerning the Cottrell patents and the Research Corporation has been passed to me for a response. The Research Corporation is grateful to you for your frank attitude and helpfulness in bringing these inquiries to our attention.

"I will be glad at a later date to make public announcement of the program which is contemplated as the proposed activities of the Research Corporation.

"In the meantime, if you will publish or reprint the contents of a pamphlet which is transmitted to you enclosed in this letter, and which describes the organization and activities of the Research Corporation, you may give your readers a better understanding of our operations.

"To your correspondent this communication is primarily addressed. We want him to know that the original stockholders participated without any expectation of any dividends and subsequently, out of accrued royalties, their investment in this stock was refunded, and that the Research Corporation owns all of its stock and has never declared any dividends.

"The funds which have been expended have been based upon a salary scale so low that the devoted staff who have worked so enthusiastically to introduce electrical precipitation into modern industry have had scarcely more than the prevailing living wage.

"Research Corporation has persisted in its endeavor to introduce into the industrial arts the possibilities of this invention and for a number of years did so without profit, accepting annual losses, especially during the war period.

"The Research Corporation has no direct affiliation with either the General Electric or the Westinghouse Electric company. It operates entirely independent of them, using the apparatus of both only where it has proved itself to be the best and cheapest for the purpose. None of its officers or its directors have served either of these companies in any capacity which would lead to the intimation contained in this letter of your correspondent.

"Yours very truly,

"A. A. HAMERSCHLAG,

"President, Research Corporation."

A Heating Problem

The following letter contributes another solution to the problem confronting a mine manager as outlined in the issue of April 21, 1923:

"I put a stop to the formation of the so-called 'creosote' incrustation in the stovepipe from an ordinary king heater type of wood-burning stove by puncturing air holes in the back of the stove just below the pipe exit—the stove having no counter draft.

"You correctly explain the cause of formation as the cooling processes of the pipe surface. The air feed from the rear seems to produce this process within the stove, creating, as you suggest, more perfect combustion. A Dutch oven should supply the same results. JESSE A. ZOOK.

"Joplin, Mo."

[1] *Journ. Industrial & Engineering Chemistry*, Vol. 4, pp. 864, 867, December, 1912.

THE PETROLEUM INDUSTRY

Oil Shale in Indiana

A large tonnage of oil shale lies exposed at the surface, readily available for mining operations, in a territory embracing 500 square miles in southeastern Indiana, comprising what is known as the New Albany shale formation, according to Prof. John R. Reeves, of the Department of Geology, Indiana University, in Serial 2,466, just issued by the Bureau of Mines of the Department of the Interior. The tonnage is estimated at 45,000,000,000. A much greater amount of the shale is covered by other rocks and is therefore minable only by underground methods. This buried shale lies to the west of the outcrop district. It is estimated that these tremendous masses of oil shale can be made to yield an average of ten gallons of oil to the ton.

The New Albany shale can be mined at a much lower cost per ton than can either the oil shales of Scotland or those in the western part of the United States. It is estimated that from eight to ten tons of New Albany shale can be mined by efficient methods for the same cost as that of extracting one ton by underground methods. Reducing this to barrels of oil, the cost of extracting the New Albany shale is about one-half the cost of extracting by underground methods a shale which yields 42 gal. of oil per ton and about one-fourth the cost of extracting by the same method a shale which yields 23 gal. of oil per ton.

In comparing the costs of producing crude oil from the New Albany shale with the cost of producing oil from other oil shales, the greatest difference is found in mining costs. This advantage is in favor of the New Albany shale and more than makes up for its comparatively low yield of oil per ton of shale, previously given.

The outcrop district of the New Albany shale, running north and south, is about fifty miles long by from five to ten miles wide, and is situated between the towns of North Vernon and New Albany. This district takes in parts of Jennings, Jefferson, Jackson, Scott, Floyd, and Clark counties.

Test Well Suggested in Nesson Anticline in North Dakota

Facts indicating that northwestern North Dakota, though strictly wildcat territory, may contain pools of oil and gas, and that the area included in the Nesson anticline is the most favorable one to be tested first to determine whether such pools exist in the region, are set forth in a statement just issued by the Department of the Interior. A well drilled two to three miles south of Hoffland, W. T. Thom, Jr., believes, should reach the Dakota sandstone at a depth of about 4,500 ft., and it might encounter productive beds at less depths. In view of the expense and risk attending such a test, it would seem to be one that might well be undertaken jointly by several companies, and it should be made with great care, in view of the value of an accurate determination of local subsurface stratigraphy and of the possible oil and gas content of the several porous strata that may be penetrated. If possible, arrangements should be made to drill through the Dakota and Lakota sandstones to determine the age and character of the underlying formation.

As is shown by the Ray topographic map issued by the U. S. Geological Survey, the suggested site for the Nesson anticline test well is near the north bank of Missouri River and is eighteen to twenty miles by road from the Great Northern Ry. at Ray. Fuel for drilling can probably be most easily obtained from one of the many local lignite mines and prospects, but eastern coal could be hauled from Ray.

Output of Mexican Wells Decreases

H. Bentley MacKenzie, Assistant Trade Commissioner at Mexico City, reports to the Department of Commerce that Mexican wells produced on the average about 100,000 bbl. per day during April, but that the wells now coming in are as a rule of much smaller production than formerly. There is said to have been a large increase recently in the number of requests for drilling permits, most of these requests covering territory already proved on the Gulf coast. Increasing development activity is reported from a region of Vera Cruz known as El Maguey, on the Hacienda of El Calvario. The Corona Oil Co. is already drilling its first well in this field and the Mexican Eagle and two American companies are said to be preparing to drill in the same district. The Corona is installing a pipe line to carry oil from Pecero, and is said to be projecting the construction of a branch railroad from Panuco to the Hacienda of El Calvario for a possible later continuation to the port of Tuxpam.

Drilling Projected in Southern Arizona

There are at least two groups of operators that propose to drill for oil in the southern part of Arizona, and, if organization plans are perfected, drilling is to be started in the near future. F. L. Davis, representing Los Angeles capitalists, is now in Bowie, where he is securing leases on land in the San Simon Valley, just north of that place. The company that Mr. Davis represents proposes to sink a well, provided at least 15,000 acres can be leased in that section. The United States Oil Co. sank a well in this territory to a depth of about 1,000 ft. two years ago, and it is likely that the new leasers will deepen this well, if it is found to be possible. Definite plans have been announced for the exploration for oil in Cochise County, and leases for about 15,000 acres have already been secured. The company expects to continue leasing until a total of 30,000 acres has been obtained. The territory to be prospected comprises that area just east of Douglas and near the New Mexico border, in the southeast corner of the state.

Technical Papers

Transactions A.I.M.E. — Vol. 68 of the transactions of the American Institute of Mining and Metallurgical Engineers, New York, has recently been issued to paid-up members. It is a tome of over 1,200 pages, containing the papers and discussions presented at the New York meeting in February, 1922, except those on iron and steel (which were printed in Vol. 67), and the San Francisco meeting, in September, 1922; also the proceedings of the San Francisco meeting, including a full list of officers and committees. The papers cover a wide variety of subjects of interest to mining engineers. To non-members the price is $5.

Canadian Iron—Part II of the Fourth Annual Report on the mineral resources of Alberta, 1922 (price 25c. from the Department of Geology, University of Alberta, Edmonton, Alberta, Canada), is a 33-p. booklet describing "An Occurrence of Iron on Lake Athabaska." In the summary it is stated that "there is no commercial deposit of iron ore exposed around Fishhook Bay, and, furthermore . . . the surface exposures do not indicate that enrichment can be expected at depth which would produce an economic deposit of iron." There is no present chance for the commercial development of any iron ore deposits which might be found about Lake Athabaska, according to the report.

Lake Superior Iron Ore—The average cargo analyses of Lake Superior iron ores for the 1922 season have been compiled and issued in booklet form by the Lake Superior Iron Ore Association, Kirby Building, Cleveland, Ohio.

Canadian Maps — The Geographic Board of Canada has issued a catalog of the maps in the collection of that board, accompanied by maps of the various provinces, with the areas covered by the various individual maps in the collection outlined in blue. The Board has no district maps for distribution, but this catalog will be a valuable index to the maps that have been prepared for various sections of the Dominion. Copies of the catalog and accompanying provincial maps are presumably obtainable on request to the Board, at Ottawa.

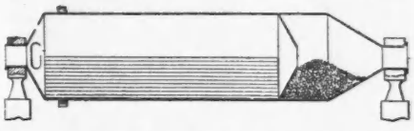
Mineral Resources—Recent additions to the "Mineral Resources" series include: "Summary of Mineral Resources of the United States in 1919," pp. 157; "Cadmium in 1922," pp. 5; and "Summary of Mineral Production in Foreign Countries, 1919 and 1920," p. 51. Any of these may be obtained on request from the U. S. Geological Survey, Washington, D. C.

Mine Timber Preservation — The Forest Products Laboratory, Madison, Wis., has issued a mimeographed two-page bibliography of important articles on the properties and treatment of mine timber, which it will send on request.

Mining Methods—The *Proceedings* of the Lake Superior Mining Institute, twenty-second annual meeting, held at Houghton, Mich., Aug. 28, 29, and 30, 1922, have recently been issued from the office of the secretary, Ishpeming, Mich. The longer papers include: "Co-operative Effort in the Study of Mining Methods"; "Development and Extraction Methods for Lake Superior Copper Deposits"; "Recent Practice in the Use of Scrapers on Sublevels"; "The Mining Methods of the Copper Range Company"; "Building Reinforced Concrete Shaft Houses"; "The Mayne Loader"; and "Why Do We Need a Classification of Mining Methods?" A list of officers and members and a map of the Michigan Copper Country are included.

Recent Patents

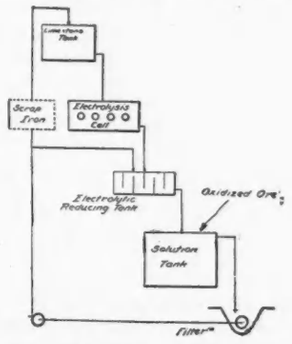
Rod Mill—No. 1,449,751. March 27, 1923. H. W. Hardinge, New York City. A mill of the cross-sectional design shown in the illustration, using rods for the first grinding, after which the pulp passes through a conical outlet into a



secondary chamber in which balls or pebbles are the grinding media. This compartment also has a conical discharge.

Continuous Thickener—No. 1,452,151. April 17, 1923. A. L. Genter and G. C. Jones, Salt Lake City, Utah, assignors of one-half to the General Engineering Co., Salt Lake City, and one-half to A. L. Genter. A form of the Genter thickener, this being a positive pressure filter with means for cleaning the filter fabric by an occasional reversal of the current of pulp.

Electrolytic Iron—No. 1,451,333. April 10, 1923. F. A. Eustis, Milton, C. R. Hayward, Quincy, and H. M. Schleicher and Donald Belcher, Boston, Mass., assignors of one-half to F. A. Eustis and one-half to C. P. Perin, New York City.



A ferric solution is reduced by an electric current and then transferred to a separate cell where the iron is deposited. A flow sheet as shown in the accompanying cut is presented.

New Books

General Chemical Analysis

Standard Methods of Chemical Analysis. By W. W. Scott. 3d ed. 2 vols. D. Van Nostrand Co., New York. Price, $10.

In the present edition, the subject matter has been entirely revised and largely rewritten, so that the methods given are the latest and most reliable that have been devised. In previous editions, the editor, Professor Scott, enlisted the aid of numerous notable collaborators, and to this list, in the present edition, have been added the names of a number of other specialists.

Of the methods which were included in previous editions, many have been deleted as being either unreliable or of not sufficient importance to be retained. The value of this phase of revision in chemical literature cannot be too strongly emphasized. It has been the experience of nearly all laboratory workers that totally unreliable methods have been retained in succeeding editions of well-known books, and these methods may be, and too often are, incorporated without revision in works by other writers. Or it may be that a given method, yielding reliable results under the very special conditions for which it was devised, will be utterly valueless under other conditions. Such methods, of course, are of certain value, but it is questionable whether they should be included in a book purporting to give "standard" methods.

In the book under review, the methods given are for the most part of general application, but in order that the busy operator may modify such methods to meet special conditions without consulting numerous scattered references, the information he will require for such modification has been carefully collected and incorporated with the descriptions of the several methods. This has proved to be an extremely valuable feature of the book.

Of the new matter appearing in the present edition, special mention may be made of the following chapters: Standard Method of Sampling, Barnitt; Sanitary Examination of Water, Hale; Radium, Roberts; Gold and Platinum, Skowronski; Examination of Explosives, Storm; Asphalts, etc., Abraham; and Electrometric Titrations, Kelly. In addition, much new matter has been added to the chapters on Cadmium, Zinc, Selenium, Tellurium, Molybdenum, Tungsten, Uranium, and Alloys, and all other chapters have been brought thoroughly up to date.

A valuable section of the book is devoted to qualitative examination of substances. This section is very concise and is particularly useful to the busy chemist. A splendid set of useful tables is given, including a long list of conversion factors which have been recalculated on the basis of the latest atomic weights. R. M. COLEMAN.

SOCIETIES, ADDRESSES, AND REPORTS

M. I. T. Inaugurates Stratton President

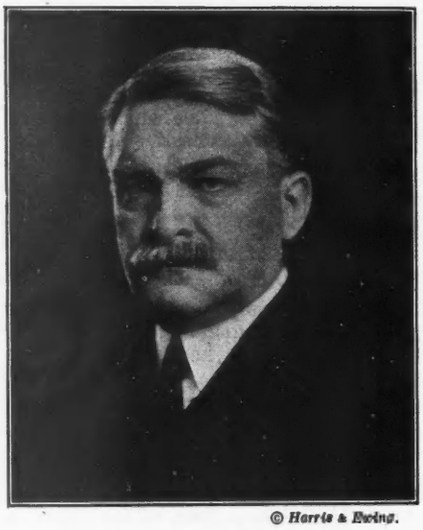
Former Director of U. S. Bureau of Standards Installed in New Office in Presence of Representatives of Other Educational Institutions

FORMAL INAUGURATION of Dr. Samuel Wesley Stratton as president of the Massachusetts Institute of Technology took place at Boston on June 11, in the presence of the representatives of many educational institutions in this country and abroad. In his inaugural address Dr. Stratton referred to a Latin motto carved in the office of the president of the Institute, which he translated as "Every Finish Marks a Fresh Start." This he said was most appropriate to the work of the Institute as well as to the progress of science in general. Continuing Dr. Stratton said:

"It has taken a hundred years to bring the steam locomotive to its present state of perfection, but it has taken only a third of the time to develop electric power. Twenty years ago a generator with a capacity of 5,000 kw. was a very large machine. . . . Less than a quarter of a century ago the automobile industry was in its infancy; today it is one of the largest . . . The navigation of the air is another dream that has come true with astonishing rapidity . . . Electrical communication is another series of developments illustrating in a striking manner the evolution of industry at a rate depending upon that at which scientific data is produced . . . With suitable equipment it is possible for a single speaker to be heard in every part of the country, through wired or radio telephony or combinations of both. These illustrations have been chosen from the utilities with which we come in contact daily; they are so familiar to us that the vast amount of effort which has brought each about is generally forgotten . . . The same process is going on in the fields of pure science as this term has been used. The terms pure and applied science have not the same distinction as formerly. The same men, methods, and equipments are involved in getting at the facts, whether they are needed in solving problems of industry or in extending our knowledge of principles. There are a few cases in the latter that do not find immediate application; in fact, the need for such information in industry is very often the incentive for its production."

Citing researches in electromagnetism and radioactivity as instances where the fundamental principles prove to be of great scientific or economic importance, Dr. Stratton said:

"In earlier times industries were slow to utilize results of scientific discoveries, whereas today they are asking for them. They are building and equipping laboratories in order to initiate and expedite research that may lead to improved processes, greater efficiency or the prevention of waste. Industries are asking for engineers well equipped with the fundamentals of science and mathematics, but up to date, which is no easy matter, considering the rate at which scientific developments are going on . . . To meet this requires far more in the way of facilities than heretofore."



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Dr. Samuel Wesley Stratton
President, Massachusetts Institute of Technology

In closing, Dr. Stratton said:

"Let us not overlook the very finest exemplification of our motto—the leader who in the following of his profession not only accomplishes results that make other and greater things possible, but who by devotion to his work and interest in his fellow man inspires others to begin."

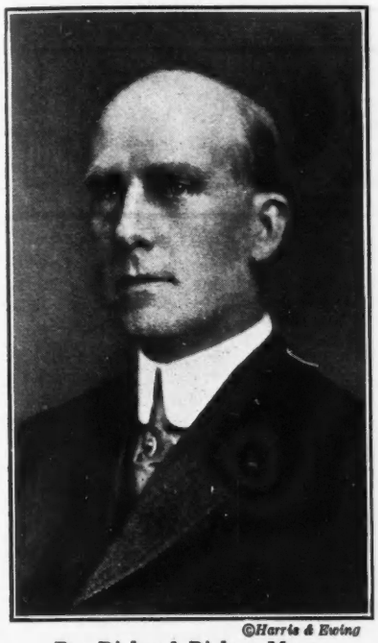
Charles William Eliot spoke for the founders of the Institute. To his thinking there were just two persons, he said, Mr. and Mrs. William Barton Rogers. He sketched the career of each and told how from their efforts a new school of applied science arose from which had developed the present Institute. The work of founding the Institute had been a pioneering work, he said, that had proceeded from and been supported by private individuals. The government of the Institute had always been chiefly composed of private citizens. This taught, said Dr. Eliot, that all pioneering education must be done by private persons and private institutions, that other schools could not be expected to do the pioneering work of education, and that they never had done that work in the last three hundred years of American experience.

John Campbell Merriam, president of Carnegie Institution, said:

"It is appropriate that an educational body such as the Institute of Technology should choose as its leader a man who has gained eminence in the fixing of standards and in teaching their use to the nation. It is also important to note that he is a distinguished constructive scholar, an experienced student of engineering application, and a man who stands firmly for straight thinking. There could be no better preparation for one who is to be concerned with higher education of this character than to have learned through much experience, the meaning of the term "standards," and to have come to know how the practical needs of the nation's most advanced business and service should use these guides and patterns.

"We know that institutions of higher learning attract those who through their desire for the most advanced knowledge give evidence that they are destined to be leaders in thought and in action. Our training should be planned to prepare that leadership for the conditions which will exist when the responsibility arrives. It should be part of the requirement of teaching that these conditions be kept constantly in mind. If a man graduates today at twenty-three, equipped only with the technique of operation in an engineering subject, he will find himself twenty years later, at forty-three, living in an engineering world of almost completely changed technique. The advances which will have come since his graduation will be partially through mere readjustment of the machinery, but many of the greatest modifications will have been produced through development of new types of application based upon fundamental principles in the sciences. A man who graduates today with the foundations of engineering well laid in the physical sciences is the one who will adapt himself most readily in meeting the new needs of the future. He will be the creator and the leader. Those who base their education solely upon methods of operation of today and yesterday will follow where others direct.

"The continued existence of the complicated cultural system which we call civilization depends on our ability to construct an educational plan in which the elements can be made increasingly simple and more fundamental, and that failure to support a system including knowledge of the most highly developed stages means going backward."



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Dr. Richard Bishop Moore
Head of development department, The Dorr Company

Dr. Richard Bishop Moore, formerly chief chemist and mineral technologist of the U. S. Bureau of Mines, is now in charge of the development department of The Dorr Company, of New York.

John S. Stewart, of London, is visiting the United States.

Ralph H. Jarvis is prospecting in California—as a recreation.

H. A. C. Jenison, of the U. S. Geological Survey, is in San Francisco.

John C. Ryan has recently returned to the United States from a trip to South America.

Edwin E. Chase will be at Butte, Mont., till June 15, after which he will go to Tonopah, Nev.

Lloyd T. Emory is in British Guiana on professional work. He will return to New York, it is expected, early in August.

L. K. Fletcher has been appointed general superintendent for Noranda Mines, Ltd., Haileybury, Ontario.

Howard D. Smith, president of the Consolidated Copper Mines Co., at Kimberly, Nev., was in San Francisco recently.

R. G. Hall, metallurgical engineer of San Francisco, will visit St. Louis and New York on professional business during June.

Felix Edgar Wormser, assistant editor, *Engineering and Mining Journal-Press,* is making a field trip through Colorado and Utah.

W. C. Northey, superintendent of the Mahoning mine, Hibbing, Minn., operated by the Mahoning Ore & Steel Co., has resigned his position.

George W. Lambourne, general manager of the Park Utah and Park City mining companies, who has been in the East, has returned to Salt Lake City.

C. E. Cairnes, of the Canadian Geological Survey, has started field work in the Hope-Princeton district, where there is a marked revival of mining activity.

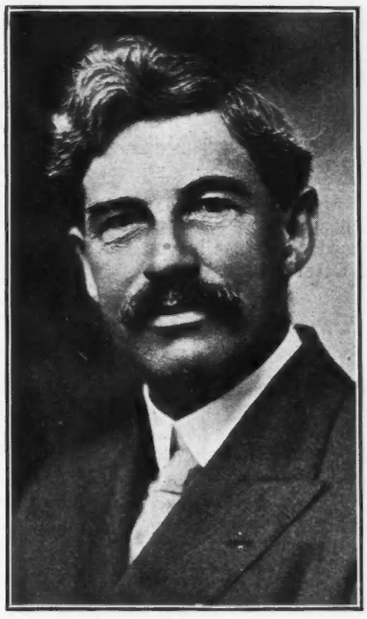
MEN YOU SHOULD KNOW ABOUT

Charles H. Munro has returned from the Federated Malay States, where he has been directing the work of the Yukon Gold Co. in its tin-dredging operations.

Cecil Rowe, manager of the Kinney Colleries, at Tokay, N. M., has been awarded the advanced degree in mining engineering from the New Mexico School of Mines.

Dr. and Mrs. **Louis D. Ricketts,** of Warren, Ariz., have arrived in New York from an extended tour through South America. Dr. Ricketts is a former president of the A.I.M.E.

George H. Ashley, State Geologist of Pennsylvania, recently delivered lectures on the mineral resources of Pennsylvania, at Mont Alto, Myersdale, Bloomsburg, and State College.



George H. Ashley
State Geologist of Pennsylvania

F. W. Draper, of the Russo-Asiatic Consolidated, Ltd., Pinners Hall, Austin Friars, London, is in New York in the interests of that company. He is making his headquarters with Knox & Allen, 160 Broadway.

Fred R. Low, Editor of *Power,* was nominated as president of the American Society of Mechanical Engineers for 1924, by the nominating committee of that body, at the spring meeting of the society, held in Montreal, May 28-31.

John G. Kirchen, general manager of the Tonopah Extension Mining Co., and president of the Nevada Mine Operators' Association, has returned to Tonopah from an extended trip to Pittsburgh, Washington, and other eastern points.

Ralph J. Orynski has succeeded **A. J. Weinig** as superintendent of the United Comstock mill at Gold Hill, Nev. Mr. Weinig has gone to Denver on research work for the Metals Exploration Co., of which the United Comstock is a subsidiary.

K. I. Marshall, engineer for the Western Precipitation Co., of Los Angeles, Calif., sailed from San Francisco for Sydney, Australia, on May 29. He will superintend the installation of a Cottrell treater at the smelter of the Electrolytic Zinc Co. of Australasia, Inc., at Risdon, Tasmania.

A. J. Thompson, of the Montana State School of Mines; **W. B. Gonser,** of Purdue University; **Albert F. Clark,** of the University of Colorado, and **Gerald U. Green,** of the New Mexico School of Mines, have been awarded fellowships in mining and metallurgy by the University of Utah.

George A. Stahl, president of the Colorado Metal Mining Association, and **M. B. Tomblin,** secretary of the Colorado Metal Mining Fund, left Denver June 8 to attend a meeting of the board of governors of the Western Division of the American Mining Congress, which convened in San Francisco June 11, 12 and 13.

OBITUARY

John H. Jones, a well-known mining engineer of Spokane, Wash., was accidentally drowned June 1 in the Moyle River near Bonners Ferry, Idaho, where he was building an arch dam for the Cynide Gold Mining Co. He was forty-five years old. Mr. Jones was a veteran of the Spanish-American War and a captain of engineers in the World War.

Andy Onstot, the last of the pioneer placer miners of the Black Hills district of South Dakota, died recently at Deadwood, in that state. Mr. Onstot was seventy-six years old. He had spent the last years of his life panning gold from creeks near his home in Blacktail.

Andy Onstot
Old-timer placer miner of the Black Hills

THE MINING NEWS

The Mining News of ENGINEERING AND MINING JOURNAL-PRESS is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Leading Events

FEE OWNERS of iron-mining properties in Michigan sue to recover for loss of royalties resulting from alleged "bad" mining practice on part of operators. Want damages for injury to mine, also.

Vipont Silver mine, in Utah, will curtail production drastically as a consequence of completion of Pittman Act purchases. Operators in Cochise County, Ariz., will suspend for the same reason.

Prospects in the Slocan district, in British Columbia, improve. The Trail zinc schedule has helped.

Idaho geologist estimates 5,500,000,000 tons of $12 phosphate ore in the southern part of the state.

The United States S., R. & M. Co. has resumed development of its properties at Eureka, Nev.

Lower smelting rates have been established by the A. S. & R. Co. on ores from the northern part of Colorado.

Operations in the Joplin-Miami zinc-lead district have slackened because of lower prices for concentrates.

The Inspiration Consolidated Copper Co. is installing an 800-kw. turbine generator at its Miami power plant.

A branch railroad in the Park City district of Utah will stimulate operations in the eastern section. Park-Utah will benefit.

Owners Seek Damages for Alleged Bad Mining by Operators

Legal Battle Between Expert Witnesses Involves Iron Mines—Similar Suits May Follow

Mining men of the Lake Superior iron-ore region await with interest the outcome of the lawsuit between the fee owners of the Homer mine, on the Menominee Range, and the Buffalo Iron Mining Co., operators of the property. The case was heard by Judge R. C. Flannigan, in the Dickinson circuit court. The fee owners claim that the operators used improper methods in mining the ore, causing the surface to cave and sand to mix with the product. As a result, it is maintained, instead of an ore extraction of between 85 and 90 per cent, only 72 per cent was recovered. It is further claimed that when the third level of the mine was reached the operators should have changed from the sublevel system of mining to the top-slicing method. Damages amounting to 24c. a ton on approximately 310,000 tons of ore are asked, and an additional sum because of damage to the mine itself.

Expert witness were used by both sides, F. W. Sperr, head of the mining department of the Michigan College of Mines, being one of the witnesses for the Buffalo Iron Mining Co. E. W. R. Butcher, G. L. Woodworth, C. H. Campbell, James E. Jopling, and other prominent iron mining men of the Lake region also testified. The result will be of considerable importance, as there are a great many mines in the Lake country which are operated on the same basis, and there are rumors of other suits if the plaintiffs are successful in this lawsuit.

Gold Veins Near Iditarod

A telegram from a correspondent at Iditarod, Alaska, says that two rich veins of free-milling gold ore have been traced for 1½ miles on the right limit of Otter Creek.

Two New Steel-Concrete Ore Docks on Lake Superior

The Great Northern R.R. is making preparations to erect a new steel-concrete ore-loading dock at Superior, Wis., at the head of Lake Superior. The Chicago & Northwestern road is to build a new dock, to replace the wooden one now in use at Escanaba, Mich., on Lake Michigan.

Granby Saves $100,000 by Winning Tax Suit in B. C.

In the Supreme Court of British Columbia, Chief Justice Hunter has ruled that the Attorney General of British Columbia must pay the whole of the costs in connection with the suit of the Granby Consolidated M. S. & P. Co. vs. the Attorney General, which was fought through the several courts up to the Privy Council, the costs in which will run into several thousand dollars. In this suit the Granby company claimed that its income tax, amounting to several hundred thousand dollars, did not become delinquent until the end of 1922, and if paid before that time was subject to a rebate of 10 per cent, whereas the Attorney General claimed that the tax became delinquent at the end of 1921. By winning the suit the Granby company saves more than $100,000, including the rebate, the costs of the litigation, and interest saved by deferring payment.

Branch Railroad in Park City District, Utah

Will Serve Park-Utah, Silver Bonanza, and Stimulate Development in Eastern Section

It is announced that the Union Pacific proposes to build a five and three-quarter mile road from Park City, Utah, into the eastern section of the district, connecting with the mouth of the Ontario drain tunnel. Although the line will not cover any great length, difficulties in construction bring the estimated cost to about $400,000.

As is well known, there has, until lately, been little work done in the eastern section of Park City. The bringing of the Park-Utah into active production in this part of the camp within the last three years, so that it now is one of the important silver-lead mines of the country, producing at the rate of over 3,000,000 oz. of silver yearly, has aroused much interest in the possibilities of eastern Park City. The new railroad will primarily benefit the Park-Utah.

The company is now hauling its ores underground through the Ontario No. 2 drain tunnel to the Daly West shaft, hoisting the ore 900 ft. to the Ontario No. 1 drain tunnel, and taking it from there out to the Ontario loading station. The total haulage by this route amounts to practically three miles. With the new line in operation, the distance from the Park-Utah workings (where ore is now being mined) to the loading station will be reduced to one mile. Other properties in the eastern section are: the Glenallen, which has a milling plant; the Park-Bingham and East Utah. With the reduction in the cost of bringing in supplies, work on properties so far little developed will be stimulated.

Prospects Are Brighter in the Slocan District

Production Steady—Development Active—Old Mines Reopened—Smelting Contracts Less Onerous

THE zinc schedule which went into force at the Trail smelter of the Consolidated Mining & Smelting Co. just a year ago has been the means of putting new life into the old Slocan district, at British Columbia. The Silversmith, of course, is the leading mine: it has shipped 4,300 tons of concentrate to date this year, 2,000 tons of which has been zinc concentrate that, prior to the introduction of the schedule, was a waste product. Lessees at the old Standard mine have shipped 800 tons of concentrate this year, 700 of which was has yielded more than a $1,000,000, and it was the profit from its operation that enabled Clarence Cunningham to develop the group of mines in which he is interested. His Alamo mill is busily employed just now on ore from the Wonderful mine, and 200 tons of lead and 200 tons of zinc concentrate have been shipped to Trail during the last few months.

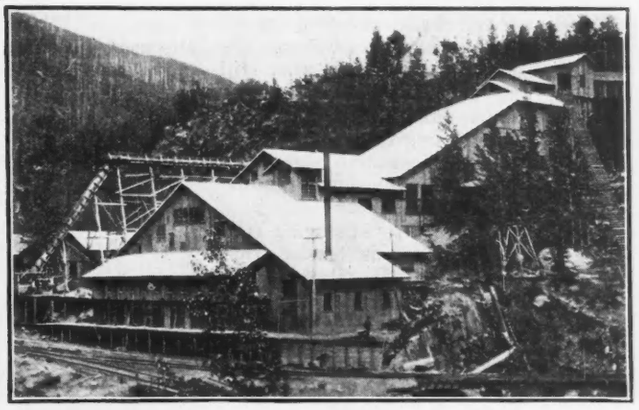
The Bosun has shipped 500 tons of crude ore this season, and is said to have developed an excellent ore reserve. The Ruth-Hope mine, which is developing an extension of the Silversmith vein, has shipped 175 tons. This property is being developed under the guidance of R. H. Stewart, formerly manager for the Consolidated Mining & Smelting Co., who, it is said, was responsible for the discovery of the new oreshoot in the Slocan Star vein when the Silversmith company took over the property. A new vein, parallel to the Slocan Star vein, is being explored in Ruth-Hope territory, and is said to be showing great promise.

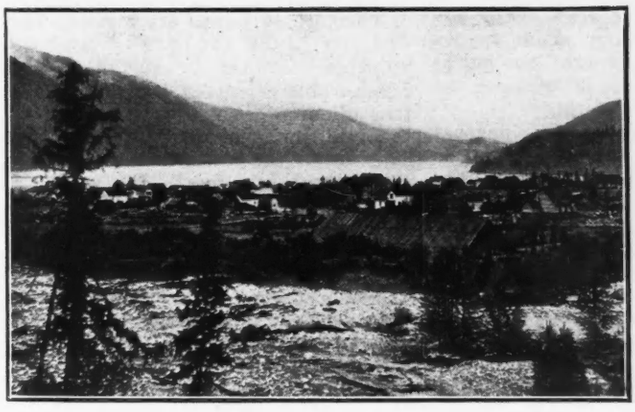
The three mining centers of the Slocan—namely, Slocan, Silverton, and New Denver, the former being situated in the valley of Carpenter Creek and ringed with mountains and the latter picturesquely located on the shores of Slocan Lake—have been hustling little communities since about 1892, when mineral production started. It was then that shipments began to be made by such properties as the Slocan Star, Payne, Reco, Rambler Cariboo, and Whitewater.

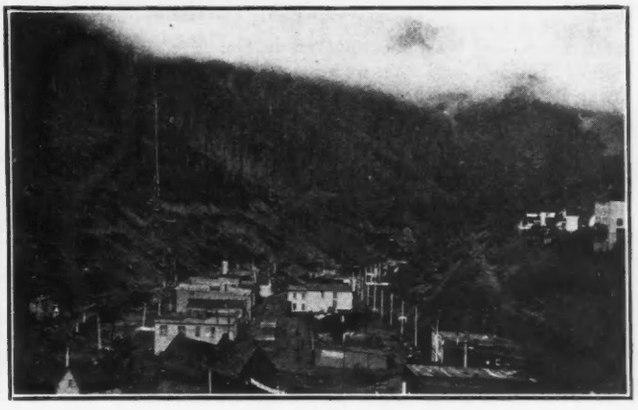
Although large tonnages of clean galena have been recovered, the bulk of Slocan ore has to be concentrated to separate the lead from the zinc and make as near as possible a clean lead and a clean zinc product. The result has been the erection of numerous concentrators, and today the district has several modern plants for the treatment of silver-lead-zinc ore by gravity and oil flotation.

The leaser, and the prospector also, have a happy hunting ground in the Slocan. The topographical conditions lend themselves to cheap mining. The hillsides are steep and covered with timber. Water needed for power sites and concentrating is available. Orebodies, with few exceptions, can be approached by adit tunnels. Railway or lake transportation is within easy reach of rope tramways, which are used extensively for conveying ore from the higher altitudes. There are good roads and first-class mountain trails. The climate is moderate, the winter being not excessively cold and the other seasons ideal.

Most of the ore mined has been argentiferous galena, associated with zinc blende in a gangue of siderite, calcite, and quartz. The average run of the ore carries about 2 oz. of silver to each unit of lead.







Noble Five mill, Sandon (above)
New Denver, on Slocan Lake (below)

Alamo mill (above)
Sandon, a typical Slocan town (below)

zinc concentrate. This, however, is rather in the nature of a swan song, as most of it was derived from pillars left for support in the prosperous days, and, unless some new ore is found, the end of the old mine, which has paid its owners $2,700,000 in dividends, is in sight.

The Standard company is steadily exploring the Iva Fern, the McAllister, and a group of claims near to the old Standard mine, in the hope of finding a property in which to invest nearly half a million dollars that has been held in the treasury for that purpose for more than four years.

A promising new strike has been made at the Queen Bess mine, which, it is thought, will give this famous old property a new lease on life. The mine

Many Silver Operations in Cochise County, Ariz., Will Suspend

Cannot Make Profit at 65c. Price—Others Continue—Think "Tender" Privilege Abused

Many of the silver mine lessees and operators of Cochise County, Ariz., which area produces over half of the silver mined in Arizona, are making preparations to close down their properties, owing to the expiration of the Pittman Act price for the metal. The Tombstone district, which has experienced a great period of activity during the last year, will witness the closing of over half its mines. However, there are some that will continue to operate and will undoubtedly be able to make a good profit if the present price of silver is maintained.

Massey & Williams, operating the old Oregon mine under lease from the Phelps Dodge Corporation, Bunker Hill Branch, will continue mining. These men have taken out a large tonnage of high-grade ore during the last year and are in position to continue shipments from ore already developed for some time.

Liedy & Bergquist, operating the Promptor mine, which is leased from the same corporation, are also reputed to have reserves that will enable them to carry on with the cheaper price for the metal. Benson & Alberts, who are operating the Silver Thread mine, leased from Phelps Dodge also, are in a similar position.

About two months ago, a body of high-grade ore was encountered in the Silver Thread, and the owners of the lease have rushed shipments as fast as possible since that time. The new mill on the Bonanza property, which was completed about the middle of April, is continuing to operate, treating ores that had been stocked during many months. Wooton, Hilton & Jacobson, who have leased the Bonanza mine from J. L. Melgren, the owner, evidently feel that by efficient mining and milling a profit can be realized from the ore that they are producing, even at a reduced price for silver.

The Commonwealth mine, which is at Pearce, is to suspend operations, owing to the present unsettled condition of the silver market; operators are cleaning up all ore that has been mined in preparation for the shutdown. Operation up to this time is said to have returned a good profit, but 65c. silver is a different matter.

Much dissatisfaction has been expressed by silver operators concerning the abruptness of the Treasury Department announcements and the uncertainty connected with the purchase of the final metal under the Pittman Act. Some claim that the privilege of filing affidavits concerning silver has been abused and that in some cases affidavits have been filed by mine owners claiming silver values of ore that has just been mined and has not been taken out and that others claim values for ore blocked out in mines and not even touched.

New Equipment in Sante Fe Concentrator in Oklahoma

About $25,000 worth of new machinery is being installed in the plant of the Santa Fe Mining Co., south of Hockerville, Okla. The company is sinking a new shaft to the 240 level, and by the time it is completed the mill will be ready for operation once more. Included in the new machinery is a 200-hp. Chicago Pneumatic oil engine and a 1,100-ft. compressor. The company has sold only 100 tons of zinc ore this year, and has several thousand tons in its bins, awaiting better prices. M. B. Davidson is manager.

Terlingua, Texas, Produced 40 Per Cent of Country's Mercury in 1922

Discovery of Coal Near Mines Stimulates Activity—Railroad 90 Miles Distant

Of the total of 6,497 flasks of quicksilver which were produced in the United States last year, 2,725 flasks came from the cinnabar mines in the Terlingua district, in Texas. There has been a revival of the industry in the district in the last year, and preparations are being made for the opening of several more promising properties. Extensive prospecting recently has established the fact that there are outcroppings of rich cinnabar ore scattered over a territory running thirty miles east and west from Terlingua and having a width of about twenty miles. It is asserted that the quicksilver resources of the district are the largest known in the world.

One of the chief reasons for unusual activity in opening up new mines is that the tariff of $18.75 which Congress recently placed upon quicksilver is expected to cause a corresponding raise in the price. At present the quicksilver sells for $67.35 a flask of 75 lb. in San Francisco.

The largest producer of quicksilver in the Terlingua district is the Chisos Mining Co., which has been producing regularly at the rate of about $30,000 a month for many years. It has a record of having produced a total of more than $2,000,000 worth of quicksilver. The workings of this mine are down to a depth of 500 ft., and it is stated that the ore grows richer as the depth increases.

Formerly one of the principal drawbacks to the industry was the scarcity of fuel for the furnaces. The mines are 90 to 100 miles from the nearest railroad point, and in a region that is bare of trees and practically all other kinds of vegetation. The fuel problem was solved unexpectedly, however, by the discovery of coal of good quality near the mines. It is now being used in most of the furnaces.

Outcroppings of cinnabar have also been found in Mexico, just across the Rio Grande from Terlingua, but as yet no steps have been taken to develop the properties on that side of the border.

Vipont Silver Mining Co. Will Curtail Output to 50 Tons

Shipped Concentrate by Special Train—Cannot Market 2,000-oz. Product Economically

Following the suspension of silver purchases at the Pittman Act price, the Vipont Silver Mining Co., operating in Box Elder County, Utah, will readjust its operations. The company, however, added a touch of color to the final days of May by shipping concentrates to a Salt Lake smelter by special trains. One train consisting of four carloads of concentrates from the Vipont mine and one carload from the Bayhorse mine, situated near Mackay, Idaho, made the trip from Oakley, Idaho, to Salt Lake in eleven hours, including the time taken for all stops and clearances. This is five hours better time than that made by the fastest passenger trains. In making the entire run at an average speed of thirty-five miles an hour, including all stops, much of the distance had to be made at the rate of sixty or sixty-five miles an hour.

The second special train of concentrates, including two carloads, both from the Vipont, left Oakley on May 29. The four carloads of the Vipont company contained about 30,000 oz. of silver, so that by expending $669 for a special train, a gain of $12,000 was made as compared to the price the same shipment would have brought should it have arrived after the expiration of the Pittman Act.

Inasmuch as Vipont ore carries silver exclusively, the company's operations will henceforward be curtailed to a considerable extent. From now on 300 tons of ore weekly will be treated by the mill, as compared with 225 tons daily during the years when the Pittman silver act was in force. Forces at the mine have been reduced from about 325 to 125 men.

By selective mining, partial operation of the mine can be maintained. The mill will be operated intermittently as the need for the treatment of the ore on hand demands.

By increasing the grade of concentrates from its present average of about 220 oz. of silver to a product grading from 1,000 to 2,000 oz. a ton—a step said to be practical by roasting and refloating—the company could probably maintain operations at nearer their present capacity with silver ranging about 60c. an ounce.

However, as the railroad companies will not accept as freight ore or concentrates worth more than $1,000 a ton, and as express rates are prohibitive, shipping of a higher grade concentrate is impractical.

Homestake Produced $490,000 in May

The production of gold bullion from the Homestake mills, at Lead, S. D., during May was $490,000. This came from treating 136,000 tons of ore. The new milling plant is reported to be working well.

Smelting Company Shoulders Part of Freight Increase

Northern Colorado Producers Hope to Stimulate Production—Denver Plant May Restart

In line with the policy of the American Smelting & Refining Co. to cooperate with Colorado mining men in an effort to revive the metal-mining industry in the state, the company has announced a new treatment rate applicable to northern Colorado ores containing values of $25 per ton and less. The new rate is $1.50 per ton less than the old schedule.

Owing to the closing down of the Pueblo smelter, northern Colorado ores must be sent to Leadville for treatment, necessitating a long haul, and a consequent increase in freight rates of about $3 per ton. The smelting company, in connection with the Denver & Rio Grande R.R., has arranged to absorb $1.50 of this increase, with the purpose of increasing production.

The operators of Clear Creek and Gilpin counties have appointed a special committee to confer with the smelter people, the State Mining Association and supply dealers, in arranging a general campaign that will lead to an increase in production sufficient to justify the blowing in of a furnace at the old Globe plant in Denver. The reopening of the Denver plant would still further reduce railroad rates, and northern Colorado operators will make a determined effort to increase output to the extent of supplying sufficient ore to warrant the move on the part of the smelting company.

American Capital Finances Mexican Mines, Say Statistics

More mines are in operation in Mexico now than at any time since the revolutionary period began in 1910, according to a statement by the Department of Mines of the Mexican Government. This is also true as to the number of titles to mines. That there is much prospecting going on is shown by the fact that 118 new titles to claims were issued during the month of April, which is the latest month of which a complete record is available.

It is estimated that approximately $290,000,000 has been invested in mines and smelters in Mexico. According to statistics, about $286,000,000 had been invested in the industry in 1912. Of this amount about $37,000,000 was in smelters and mills, the remainder being invested in mines. Of the total, about $250,000,000 was American capital; $43,000,000 English, and the balance represented French, German, and other investments. The State of Sonora ranked first in the number of mines, with 4,300 patented groups; Chihuahua second, with 4,100; Durango third, with 3,179; then following in order came Zacatecas, Jalisco, Oaxaca, Sinaloa, Hidalgo, Guanajuato, Guerrero, and Nuevo Leon.

Inspiration Increases Capacity of Its Steam-Electric Plant

Largest Mine Power Installation in Arizona—Roosevelt Dam Hydro Power Erratic

A new 8,000-kw. generator is being installed at the power house of the Inspiration Consolidated Copper Co. at Miami, Ariz. This is the largest mine power plant in Arizona. The new machine consists of a steam turbine, direct connected to the generator; it will increase the capacity of the plant to about 25,000 kw. There are now two other generators of the same type in operation, but these are rated at only about 6,000 kw. each. The installation necessitated many changes in the plant, including new switchboards and an addition to the building. However, no additional boiler capacity will be needed to care for the new load. Inspiration secures some power from Roosevelt Dam hydroelectric plant, that amount varying from nothing to half the total load. On account of the erratic nature of this supply, it is necessary to maintain the steam power plant at Miami in readiness to assume the full load at any time.

Development Resumed by U. S. S., R. & M. Co. at Eureka, Nev.

Consolidation of Mining and Railroad Interests, With View to Erecting Smelter, Still Hangs Fire

Companies operating in the old Eureka district, in Nevada, shipped 500 tons of ore, concentrate, and speiss during the week ending May 27. The principal shippers were the Richmond-Eureka, Eureka-Holly and Eureka-Croesus.

Development work is being restarted in the old Richmond-Eureka mine, owned by the United States S., R. & M. Co. The Locan shaft, now 1,200 ft. deep, is to be deepened, and upper levels from this shaft are to be cleaned out so as to continue and complete development of the known and indicated bodies of low-grade ore in this part of the mine.

The Eureka-Holly 50-ton concentrating plant is operating successfully and the company has a large tonnage of ore of mill grade in sight. The main shaft is 700 ft. deep and is to be continued to a depth of at least 1,000 ft.

The Eureka-Croesus is shipping regularly, and the management plans to prospect the ground at the depth where good ore was developed in the winze from the Catlin shaft, by doing lateral work from some of the many long tunnels driven into the east side of Prospect Mountain.

Consolidation of ownership of the Eureka-Croesus and others, and the purchase of the Eureka-Nevada railroad, which might lead to the construction of a custom smelter, have not yet been consummated, although it is generally believed that the plans are still being considered and that negotiations are pending. Should a customs smelter be built the mines in the district would be helped materially.

5,500,000,000 Tons of Minable Ore Worth $12 Per Ton

So Says V. R. D. Kirkman, Geologist—Phosphate Deposits of Southern Idaho Best in the World

Southern Idaho contains the highest grade and most extensive deposit of phosphate in the world, according to Virgil R. D. Kirkman, head of the department of geology at the University of Idaho. Mr. Kirkman, who has made a thorough study of the phosphate deposits of Idaho, predicts an industry in southern Idaho which will dwarf by comparison the exploitation of the great lead deposits of the Coeur d'Alenes and copper deposits of the Butte district, in Montana.

The Idaho deposits cover an area of 3,000 square miles, situated in Cariboo, Bear Lake, Bingham, Bonneville, and Teton counties. The total reserves minable aggregate 5,500,000,000 tons of a value of $12 per ton, according to the estimates of Mr. Kirkman.

High freight rates have made it impossible for Idaho to compete with ocean islands, but these sources of supply are fast nearing exhaustion, and Idaho's deposits are attracting the attention of rich companies. The Anaconda Copper Mining Co. is developing a large area by the driving of two tunnels each two miles long. The tunnels are designed for handling 3,000 tons daily. Other companies interested in the field are Idaho Phosphate Co., of Spokane; the Bear Lake Corporation, operating near Paris; and the American Phosphate Co., of Salt Lake City, operating near Montpelier.

Occupation of Ruhr Seriously Affects Swedish Iron Mining

The French occupation of the Ruhr district has had serious effects upon the Swedish iron-ore exports to Westphalia, according to a statement of the general manager of the Grängesbjerg Iron Ore Trust of Stockholm, which controls nearly the entire Swedish ore exports and in which organization the government is largely interested.

At the general annual meeting of the Trust, on May 25, it was said that conditions in the Ruhr district had materially reduced Swedish iron-ore exports. No shipment worth mentioning will be possible as long as the present state of affairs prevail. Westphalia takes about 65 per cent of the companies' entire ore exports. The closing up of the Ruhr district by the military authorities therefore largely influences the transactions of the company. During the past year the company has been able to export 2,830,000 tons of ore, against 2,590,000 tons in the preceding year, as it was possible to raise the exports to other countries, particularly to America, to a considerable extent, and in spite of the closing up of the Ruhr district the shipments at present amount still to about one-half of the normal. The working time in the iron mines has already been reduced to four days per week.

News from Washington

By PAUL WOOTON
Special Correspondent

Smelters Should Get $1 for Only 95 Per Cent of Silver in Ore

Such Is View of Senator Pittman—Change in Policy Made in January, 1921—Treasury Officials Stand Pat on Revocations

SUMMING UP the evidence at the hearing in the matter of metallurgical losses in the treatment of silver, Senator Pittman holds that the government should deal with the smelters, in purchasing silver, on the same basis as the smelters deal with the miners. "The smelting companies," says Senator Pittman, "rely upon the regulations of the Treasury Department to justify their position as to proportions between domestic and foreign silver. This regulation does not say actual losses. It does not prescribe any method of determining losses. It even does not permit estimated losses. Ray T. Baker, then [1920] the Director of the Mint, knew that losses were deducted by the smelters in their purchases from the miners. He knew that such deduction was an arbitrarily fixed average based on a custom of the trade. He could have meant only one thing, and that was that the 5 per cent deduction also should have been apportioned between the foreign and domestic silver purchased. That is the way the American Smelting & Refining Co. interpreted it. That is the way the American Smelting & Refining Co. conducted its business with the government from the beginning of the operation of the Pittman Act from Jan. 17, 1920. That is the way the United States Smelting, Refining & Mining Co. interpreted the act and the original regulations. Under such interpretation, that company dwelt with the government until January, 1921.

"How can the smelting companies be injured by holding them to their original interpretation of the act and of the regulations? If they had any gains over the 5 per cent deduction charged the miner, they have the open market of the world in which to sell such gains. They were satisfied with such an arrangement until Jan. 1, 1921. Why should they not be satisfied with it now? Is the Treasury Department going to follow that requirement in checking up these estimated losses and gains as suggested by Mr. Kelley and the auditor of his company? [Anaconda Copper Mining Co.] If not, will the Treasury Department have used every precaution to protect the government in the administration of the Pittman Act? There is only one answer, and that is the government either has to check up the individual plants or hold the smelting companies to the same estimated losses as they apply in dealing with the miner in making the purchase of this silver.

"In my opinion, there are several reasons why the government should not be required to go to the expense of attempting to check up the estimates coming from the individual plants. My reasons are: It would entail great expense and long delay to adjust these accounts. The result would be uncertain and unsatisfactory, because many of the conditions upon which these estimates were based originally have ceased to exist. There would be no way of checking the amount of silver that went into treatment losses and gains and which was obtained as a byproduct of copper, lead and other ores. In any event, it would be only an estimate. The representatives of the smelting companies, by their actions in the past, their custom in purchasing from miners, and by their own testimony at these hearings, have pointed out clearly that no less deduction than 5 per cent for metallurgical losses is a safe basis upon which to buy silver in ores. This expert testimony is more reliable than is any other which could be obtained. If the Treasury Department holds these vendors to settlement on the universal and accepted basis of 5 per cent metal loss, then transactions can be closed almost immediately."

Senator Pittman has received another letter from the Under Secretary of the Treasury, which reads in part as follows:

"I received your letter of May 14, 1923, with further reference to the allocation of silver for subsidiary coinage under the act approved April 23, 1918. I have already stated the Treasury's position with respect to the cancellation of these allocations in my letter of May 9, 1923, and have called your particular attention to the decision of the Comptroller General of the United States in the matter, given under date of Nov. 29, 1922.

"The Comptroller General's decision is conclusive and binding upon the Secretary of the Treasury, and the Treasury Department accordingly proceeded forthwith to revoke the allocations covered by the decision, amounting in the aggregate to 10,247,976.52 fine ounces. Your letter, I notice, seems to involve some misunderstanding of the decision, for it states toward the end that 'the opinion of the Comptroller General upon which the Treasury Department depends expressly states that the matter of revocation or non-revocation is entirely within the discretion of the Treasury Department.' What the Comptroller General said was that:

> 'The matter of coinage into standard silver dollars of the bullion . . . which was allocated and charged to the subsidiary silver account and which allocations are authorized to be revoked and recharged to the standard silver dollar bullion account, is for administrative consideration.'

This clearly means that the revocation of the allocations is authorized, and that the question of recoinage into dollars would be one for administrative determination by the secretary. That determination has been reached, and the recoinage of the silver into standard silver dollars is proceeding in accordance with the decision.

"What you say about profit to the government through revoking the allocations of silver for subsidiary coin shows a further misunderstanding of the situation. Take, for example, the 10,247,976.52 oz. of bullion once allocated and since revoked. This bullion, or its equivalent, has been in the vaults all along and is not needed for subsidiary coinage. Restoring it to the standard silver dollar bullion account does not make a cent of profit to the government. It simply puts the silver back where it was before, and when it has been recoined into standard silver dollars the government will be restored to its former position, the recoined standard silver dollars filling the place of the standard silver dollars originally broken up and melted.

". . . The purchase of silver for subsidiary coinage . . . depends entirely upon the demands of business, and it is perfectly well settled that in making purchases of silver for subsidiary coinage the government pays only the market price. The difference between the price paid and the face value of the subsidiary silver coined therefrom constitutes seigniorage, and this, as you know, accrues to the government by virtue of its sovereign power to coin money and maintain its circulation.

"The fact is, of course, that the Pittman Act has had the effect for about three years of giving American producers of silver a bonus equivalent to the difference between the world market price and the fixed price of $1 per ounce, 1,000 fine. This has amounted, on the average, to over 30c. an ounce, and the effect has been to give an artificial stimulus to the production of silver. The termination of purchases under the act will doubtless cause some disturbance of the silver industry, but that is always the result of maintaining an artificial condition and the hardships incident to returning to normal are inherent in the situation and cannot be overcome by any action of the government. The Treasury, on its part, has been doing everything possible to assure equitable treatment to American producers in making final purchases under the act, and has promulgated appropriate regulations to that end, but beyond that it cannot go. The Treasury, of course, has to consider the interests of the people as a whole, and not merely the special interests of the silver producers, and it would be manifestly improper for it to throw an additional burden of $5,000,000 or more on the taxpayers of the country in order to help producers of silver by making purchases of silver at the artificial price of $1 per ounce, 1,000 fine, beyond what is needed under the act."

Bain Will Investigate Chilean Nitrate Industry

Sailed for Iquiqui on June 14—Seeks Reliable Data for the Department of Commerce

Before making any recommendations in connection with the study being made of nitrogen supply, the Department of Commerce recognizes that additional accurate knowledge must be had as to the situation in Chile as it affects the production and distribution of nitrate of soda. It is recognized that the gathering of this information is a delicate task. For that reason it has been decided to send on this mission H. Foster Bain, the director of the Bureau of Mines, who, in addition to being the head of the government agency which represents the mining industry, is a mining engineer and mineral technologist who has had wide experience abroad. He is accompanied by Harry S. Mulliken, technical assistant. Mr. Bain's inquiry will cover adequacy of supply, grades available, and the possibility of reducing the cost of production. He sailed from New York on June 14.

The opinion has been expressed that neither the Chilean Government nor the nitrate producers in that country would welcome an emissary from the United States Government, when the avowed intention of the law under which the visit would be made is to devise means of arousing competition for one of their natural resources. It is believed, however, that a high federal official will be able to secure the necessary information, because both the Chilean Government and the nitrate producers probably prefer giving actual facts to a person of unquestioned responsibility, who could be relied upon to make only proper and accurate use of the data, rather than have the Secretary of Commerce predicate his recommendations on questionable reports. If the accurate information is withheld, the only recourse would be to secure the data from other sources. Inaccuracies would be certain to result. As a consequence, a distorted picture of the Chilean monopoly probably would be painted. The Chileans must recognize that the United States is in a position to make itself self-supporting, ultimately, in the matter of nitrogen.

Tungsten Miners Get $11,606 From War Minerals Commission

An award of $11,606.33 in favor of the Rare Metals Production Co., which operated the Ida May group of tungsten mines in Gunnison County, Colo., during the war, has been recommended by John Briar, War Minerals Relief Commissioner, and has been approved by the Secretary of the Interior. The claim was denied by the former commission because of lack of specific request or demand. Under the amended act, however, stimulation was established as of August, 1917.

Some difficulty was experienced in establishing the salvage value of the ore on the dump. The claimant argued that this ore had no salvage value, but Commissioner Briar insisted on deducting $732 for the ore, although he admits that the recovery will be small after 3 per cent ore is hauled 12 miles to the railroad and then shipped to Boulder.

Other awards have been approved as follows: Valley Forge Mining Co., manganese, $1,795.23; Arthur L. Shipley, tungsten, $581.43; Liberty Manganese Mining Co., manganese, $240; Polk Bayou Mining Co., manganese, $446.95; Tennessee Manganese Co., manganese, $217.80; Frank Balis, tungsten, $3,133.33; Walter A. Zelnicker, manganese $1,093.40; Doty Manganese Co., manganese, $2,815.81.

The following claims were disallowed: Wilson, Parker & Shepherd, chrome; J. F. McKnight, chrome; A. C. Enochs, manganese; Burnham-McClelland Mining Co., manganese; McQueen Mining Co., manganese; T. L. Ford, manganese; A. L. Wakeham, chrome; Ludwig Netz, chrome; Fred A. Babcock, manganese; James A. Shinn, manganese; Charles F. Clark, chrome; G. P. and P. H. Wallace, chrome; W. A. Hamer, manganese.

News by Mining Districts

By Special Correspondents in the Field

London Letter

Central Mining Out of Rhodesia Broken Hill—Urquhart Treats Oil Shale in France

BY W. A. DOMAN

London, May 31—At the annual meeting of shareholders of the Rhodesia Broken Hill Development Co. toward the end of last year, Edmund Davis, the chairman, when dealing with the question of water-power, said the matter had been investigated not only by members of the company's staff but also by the consulting electrical and mechanical engineer of the Central Mining & Investment Corporation. Everything was satisfactory. The Central Mining Corporation, it may be remembered, assisted in financing the Rhodesia Broken Hill, and it had been imagined would continue to work with it. The annual report of the Central Mining, recently issued, contains the statement, "Your holding in Rhodesia Broken Hill Development Co., Ltd., was sold during January of this year" [1923]. Some comment has been made upon this action, and reasons have been sought for it. In one quarter it is suggested that the sale may have been prompted by the price of lead, the decreasing consumption of zinc by the South African mining companies, and the high transport charges, indicating that on the increased capital profits will not, for some time at least, be large.

Leslie Urquhart, the moving spirit of the great Russo-Asiatic Consolidated, and president of the Association of British Creditors of Russia, has written to the press, drawing attention to Lord Curzon's note to Russia and the Russian reply thereto. He points out that although his association represents about £180,000,000 of British capital invested in Russia, the claims were not once mentioned by Lord Curzon, and that no compensation has been paid or seems likely to be paid. The attitude Mr. Urquhart has taken is admired, as he does not press the claims of his own shareholders to the disadvantage of other investors. And yet, if the precious and base metal mines could be got to work, the Russian financial and economic situation would be greatly relieved.

Leslie Urquhart and R. Gilman Brown are directors of the Var Oil & Coal Co. (France), and while awaiting developments in Russia are finding means for treating the shale on the property. They seem to have devised a successful method, and new capital is to be raised to work on a large scale.

Speculators who paid a high price for Selukwe (Rhodesia) shares on the prospects of the company's interest in B. C. Silver Mines, Ltd., are beginning to wonder whether they have made a wise choice. The report for April, just received, is by no means encouraging, for recently run drifts 200 or 300 ft. long have proved barren, and the ground is much faulted.

Montreal Letter

Discovery in Colonial Mines Has Wide Significance for Cobalt—Exploration to Proceed

BY ALEXANDER GRAY

Montreal, June 7—Continental Mines, organized less than a year ago, with Ruel C. Warriner as president, has had rare good fortune in its Colonial silver property, at Cobalt. For years the Colonial, which adjoins the O'Brien and Violet, had been coveted, but remained untouched beyond what was done in the earlier days of Cobalt, when the McCornick interests capitalized the company at $6,000,000. Most of the propositions submitted to the Germer interests, of Erie, could not be entertained. It was felt by the best-informed Cobalt engineers that the Colonial property had the greatest possibilities—greater perhaps, than any other in the undeveloped areas. Not until Mr. Germer stipulated that a shaft must be sunk to the lower contact—to which much consideration had been given by Ontario provincial geologists and others—was it at all feasible for responsible principals to deal with the Colonial. It was incorporated in Continental Mines, with the understanding that the O'Brien had mined high-grade ore at and below the 500 level close to the Colonial boundary. Mr. Warriner located a shaft; it went down to 950 ft., picked up the contact, and there is 9 ft. of milling rock with enough high-grade in it to make a profitable average.

The width and value correlate with one of the O'Brien veins. The other O'Brien veins have not as yet been located in the Colonial area. That they will be is confidently assumed, in view of the situation as it exists at the bottom of the Colonial shaft and in the drift on the contact. Ore bins in process of erection attest the intention of the Continental people to begin shipping.

The Colonial and Silver Cliff mills, both held by Continental, will have to undergo changes. Considering the depth, width, and mining area, the Colonial is giving Cobalt pleasant half hours, by extending the life of the camp and encouraging others to take sporting chances.

Not many combinations would commit themselves to expenditures on deep shaft-sinking. The Continental Colonial shaft is the deepest working in the camp in the grade of ore now being hoisted. Leaf silver, nuggets, and smaltite are the features of this latest development, to which emphasis is added by the La Rose developments to the north of and near to the Colonial boundary.

At 635 ft., the La Rose Violet property has disclosed ore on the same lower contact; 300 ft. deeper, the Colonial has it. The O'Brien, to the northwest, has had it from 500 ft. down. That is why Cobalt owners are happier. Mr. Warriner will not venture an opinion as to whether Continental Mines has the O'Brien No. 2 or No. 6 vein. Manager Hussey is proceeding to explore the section, the object being to locate the other O'Brien orebodies. At any rate, those possessing lower contacts are less critical regarding Continental than they have been hitherto.

KOREA

Oriental Consolidated Output Increased in May

During May bullion valued at $105,600 was produced by the Oriental Consolidated Mining Co., compared with $97,416 during April. The summary for April shows: Tabowie mill bullion, from 9,825 tons, $27,743.66; Taracol mill bullion, from 10,830 tons, $25,387.35; Taracol cyanide plant bullion, $44,063.50; premium on gold for March, credited "other receipts" during April, $221.56; a total of $97,416.07.

Plenty of water for hydro-electric power was available during April. The roads were in bad condition during the month, as the sudden thaw coupled with rain at the end of March rendered them unfit for wheeled traffic. The roads are being repaired and are now better.

The Tabowie No. 8 level electric ore hoist was overwound early in April; the hoisting cable broke and the skip in its descent tore out the shaft timbers for a distance of over 300 ft. This damage has been repaired and everything is running all right again; the accident caused no injury. Native labor continues plentiful and the efficiency is fair, according to Alf Welhaven, resident manager in Korea.

ONTARIO

Dome Report Good, Though Costs Advance

The recent report of the Dome Mines Co. shows an improved position over the preceding year. Though on account of the power shortage, results were not up to expectations, the grade of the ore was $11.79, compared with $7.80, and the recovery was $4,279,000, compared with $2,809,000, in the preceding year. Profits were practically doubled and amounted to $2,427,000, against $1,245,000 in 1922.

The cost per ton was $5.25, compared with $4.56 in the preceding year, the increased cost being due almost entirely to the shortage of power. Broken ore in the stopes amounts to 500,000 tons, which is practically a year and a half supply for the mill.

One feature of the report which is of importance is the reference to the hanging wall orebodies on the 12th level. These have been cut off by a large intrusion of porphyry which is dipping at a flat angle to the north, whereas on the upper levels the dip was to the south. This porphyry intrusion appears to be cutting off the sediments in which the ore is found, and though exploration to date has not succeeded in developing ore in this particular area below the 12th level, there is still reason for believing that other orebodies may be found at greater depths. Toward the Dome Extension, however, conditions are more promising. The porphyry is dipping to the south, and new orebodies have been found, and all indications point to this part of the company's property being of great importance.

Notices of the annual meeting include a copy of the bylaw to be submitted. This bylaw provides for a transfer of the property and assets of the company to a new corporation, which will have shares of no par value. The old company, however, is to retain cash, and liquid assets not exceeding $2,000,000, which the directors may, as they shall decide, pay out in the same manner and proportion as dividends will be paid to the shareholders of the new company. No one seems to know just why this is being done, and some of the shareholders think there a joker somewhere. It is understood that opposition shareholders, representing a large number of shares, will be present at the meeting and will endeavor to force some more definite announcement regarding a dividend policy. Opposition shareholders will also endeavor to at least secure representation on the board.

Lake Shore Mill Progressing

The Lake Shore, at Kirkland, is installing a new steel headframe and is making an extension to the old mill building which will bring the capacity up to 300 tons a day. The foundations for the new crushing plant and ore bins are being built and it is hoped to have the increased mill in operation by the end of the year. The main shaft is almost down to the 800 level, where development will be started.

San Francisco Letter

Dredge Machinery Shipped to Nome

By Our Special Correspondent.

San Francisco, June 9—The steamship "Buford" departed from San Francisco for Nome, Alaska, on May 30, 1923. Part of the operating crews for the two new gold dredges constructed by the Yuba Manufacturing Co. for the Hammon Consolidated Gold Fields left on this boat, which carried supplies for the company and minor parts for the dredges. The dredges are expected to be in operation in July, thus establishing a record for rapid construction under Arctic conditions.

Eight Big Mother Lode Mines Are Operating

Crushing of ore was resumed by the Argonaut mine in the last week of May. The total cost of rehabilitating the mine and the other expenses involved by the fire that cost the lives of forty-seven men last year, as far as company account is concerned, will approximate $150,000. More or less work remains in cleaning up the lower levels, but the company should be in good operating condition in the near future. The Kennedy mine, which adjoins the Argonaut, expected to resume hoisting service on June 6, 1923, when the repairs to its hoist were to be completed. The Plymouth, Fremont, Central Eureka, Kennedy, Argonaut, Moore, Carson Hill, and Belmont-Shawmut are the important Mother Lode mines now in operation. The Moore mine recently resumed sinking and has encountered a rich vein on the 640-ft. station.

Preliminary work is being undertaken at the Balaklala mine, which is under lease to the United States S., M. & R. Co. Work at the Chicago Silver mine, at Igo, will be resumed on a larger scale in the immediate future. The Peacock Gold Placer Syndicate has forty men employed on the placer ground at the Salstrom ranch, at Orleans Bar. Preparations are being made to hydraulic the ground.

WASHINGTON

Gladstone Plans Extensive Work

The Gladstone mine, near Northport, is planning extensive operations this summer. Ten chimneys of ore have been disclosed on the company's property, and active development is proceeding on the No. 5 and No. 7 chimneys. The 200 level on each chimney will be reached by extending the shafts while mining from the 100 to the surface is being carried on. The ore, which is a high-grade lead carbonate, occurs in the form of pipes varying in diameter from several feet to 100 ft.

From the main shafts crosscuts are driven from one chimney to the other, and the ore is mined by overhead stoping and square-setting. From the 200 level chimneys No. 8, 7, 9, 5, and 1 will be developed by crosscuts. Forty cars have been shipped since Jan. 1. The last two cars netted $3,000 each. The silver content is low.

MONTANA

Midwest-Butte Will Deepen Shafts

According to A. M. Chisholm, president of the Midwest-Butte Mining Co., the Prospector shaft, now 325 ft. deep, will be sunk to the 600 level. This work will be started immediately. This shaft is in the Burlington district, and not far from the well-known silver producers, the Nettie, an Anaconda property, and the Hibernia, which belongs to the Davis Daly.

The Midwest-Butte company also controls the Garibaldi, another property in the same district. This shaft will also be sunk a distance of approximately 100 ft., making a total depth of 600 ft.

Silver ore is being mined on the 500 level of the Garibaldi. It is of such a character that sinking seems to be amply warranted.

Scratch Gravel to Resume Operations

The Scratch Gravel Gold Mining Co. is to be reincorporated as the Scratch Gravel Consolidated Gold Mines, and development is to be resumed at its property near Helena. An option for six months has been obtained on 260 acres of ground adjoining the original holdings. Last summer a vein parallel to the old vein was discovered, and this is to be explored. If surface work warrants, the old shaft will be unwatered to the 200 level, from which point a crosscut will be run. The property has yielded more than $300,000 worth of gold ore.

UTAH

Utah Silver Camps Speed Production

Shipments from Eureka for the last week of the Pittman Act amounted to 257 cars, compared with 188 cars the week preceding. Shippers were: Chief Consolidated, 104 cars; Tintic Standard, 65; Iron Blossom, 20; Victoria, 14; Dragon, 12; Eagle & Blue Bell, 10; Iron King, 7; Colorado, 6; Plutus, 4; Bullion Beck, 3; Yankee, 3; Alaska, 2; American Star, 2; Mammoth, 1; Gold Chain, 1; Little May, 1; Centennial-Eureka, 1; Colorado lease, 1. The Chief Consolidated shipment, 104 cars, compared with 100 cars the week preceding.

Shipments from Park City totaled to 6,982 tons of ore and concentrates, compared with 5,472 tons the week preceding. The Silver King Coalition shipped 3,134 tons, compared with 1,870 tons the week preceding. Shippers were: Silver King Coalition, 3,134 tons; Park City Mining & Smelting, 1,885; Park Utah, 1,023; Ontario, 675; and Keystone, 325 tons.

Keystone Resumes Shipments

The Keystone, which adjoins the Silver King Coalition at Park City, reports favorable developments during the last three months. At the time of the short closedown due to impassable roads there were accumulated from 500 to 600 tons of shipping ore and concentrates. These are now being marketed. The mill is working, and no longer hampered by water shortage. During the week ended June 2, 325 tons was shipped.

IDAHO

Coeur d'Alene Production in May

The following figures give the approximate production of the principal mines in the Coeur d'Alene region during May:

	Silver, Oz.	Lead, Tons
Bunker Hill	180,000	4,000
Morning, Federal	110,000	2,200
Hecla	117,600	2,000
Hercules	70,000	1,250
Tamarack	56,000	1,000
Callahan (*a*)	15,000	800
Success	12,500	225

(*a*) Also produced 1,800 tons of zinc concentrate

NEVADA

Nevada Con. Milling 7,000 Tons Daily

The Nevada Consolidated Copper Co. is now treating over 7,000 tons daily and is further enlarging its concentrator and installing a reverberatory furnace with a capacity of between 800 and 900 tons daily, which will supplement the two furnaces now in use. Fifteen ball mills are in operation in the rebuilt concentrator, and fifteen more are to be installed.

The Consolidated Coppermines Co., which is again producing, has been shipping high-grade direct-smelting ore at the rate of 200 tons daily, the product going to the McGill smelter of the Nevada Consolidated.

MICHIGAN

Seneca Prepares to Produce

Seneca, in the Michigan copper district, is steadily getting in condition for regular production, but before mining operations are started it will be necessary to do some work in the milling plant at Point Mills, in which Seneca has two stamp heads. The mill has been closed for three years, and tables and other equipment need overhauling. Meanwhile, construction and underground work are progressing at the property. The new hoist is being installed at Seneca shaft, and at Gratiot the foundation is in for the new rock house, and two crushers are being placed in position. A new drift has been started south from the 14th level of Gratiot toward Mohawk territory. Sinking proceeds, the shaft being bottomed at 2,000 ft. The shaft will be carried down to a depth of 3,200 ft., at which point it will connect with the third level drift from Seneca shaft. The work of putting in raises to the pockets is under way at several levels in Seneca shaft. Good progress is being made toward production, and it is hoped that miners can be obtained by the time they are needed.

Assessment by Arcadian Probable

It is likely Arcadian Consolidated will call an assessment in the near future to provide funds for a continuance of development work. It probably will be 50c. a share. Preparations are under way to resume drifting in the New Arcadian shaft, in which no work has been done for several years. It will be fall or winter before a new hoisting plant can be installed at the New Baltic shaft and work resumed at this branch of the property.

JOPLIN-MIAMI

J. C. Squires Starts Another Mill

J. C. Squires is planning to reopen the Fort Worth mill of the Carmean & Squires Co., at Picher, on June 15. The mill is a short distance to the south of the old Federal mine, which also is being operated by Squires and is proving a success. He also is operating the Quebec property and is getting good recovery there. The Syracuse No. 1, formerly the Missouri Mule, which is controlled by him, is not at present being worked.

Mogul Rebuilds After Fire

The Mogul Mining Co. has completed the building of a concentrator to take the place of the one destroyed by fire about two months ago, on the company's lease east of Picher, Okla. Part of the material was taken from the old White mine, west of Picher, but for the most part it is entirely new. Only the iron in the old jigs was used, and a complete new set of Butchart tables has been installed, with a four-compartment settling tank. Power is furnished by two gas engines. The air compressor and oil engines being used were saved from the old plant at the time of the fire. A. E. Dunlap is manager.

New Club House for Zinc Institute

The Tri-State branch of the American Zinc Institute has completed a new club house in Picher near the terminals of the Southwest Missouri R.R., which is expected to aid materially in the Institute's district activities. The building, completed, will cost about $5,000 and has been financed by local mining and supply companies. It is a decided improvement over the old club home, which was situated several blocks to the south and was but a single room, with one end housing the kitchen. The new structure includes several separate rooms, a good-sized lobby, and a comfortable porch. The first luncheon meeting was held in it on June 6, though it will not be entirely completed before the middle of the month.

MINNESOTA

Shipments Unusually Heavy

Iron-ore shipments from the Upper Lake ports amounted to 6,685,885 tons for the month of May. This tonnage shows a large increase over that of the month of May of last year, as only 1,721,466 tons had been forwarded to June 1, 1922. This increase of approximately 5,000,000 tons is remarkable, when consideration is given to the lateness of the opening of navigation and the delays encountered due to the ice fields in certain parts of the route between the upper and lower docks. The heaviest shipper was the Duluth, Missabe & Northern R.R. dock at Duluth, from which 2,027,300 tons was forwarded; the Great Northern R.R. docks at Superior handled 1,631,311 tons. New facilities are being provided for loading at various Lake ports in anticipation of a big year.

THE MARKET REPORT

Daily Prices of Metals

June	Copper, N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
7	14.75	41.75	42.375	7.25	6.95@7.00	6.25
8	14.75	41.75	42.375	7.25	6.95@7.00	6.20
9	14.75	42.00	42.50	7.25	6.95@7.00	6.15
11	14.75	41.50	42.00	7.25	6.95@7.00	6.10@6.15
12	14.80	41.50	42.00	7.25	6.95@7.00	6.10
13	14.875	41.375	42.00	7.25	6.95	6.10
Av.	14.779	41.646	42.208	7.250	6.971	6.154

*These prices correspond to the following quotations for copper delivered: June 7th to 11th inclusive, 15.00c.; 12th, 15.05c.; 13th, 15.125c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. The quotations are for prompt deliveries. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Engineering and Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

June	Copper			Tin		Lead		Zinc	
	Standard		Electro-lytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
7	66 7/8	67 3/8	73 1/2	197 3/8	198 1/4	26	25 1/4	30 1/4	29 1/2
8	67 1/8	67 5/8	73 1/2	198 1/2	198 1/2	26	25 3/8	30 5/8	30 1/2
11	67 1/2	67 5/8	73 1/2	197 1/8	197 1/4	26	25 1/4	30 7/8	30 3/4
12	67 7/8	68 3/8	74 1/2	197	197 3/8	26	25 1/4	30 3/8	30 5/8
13	68 3/8	68 3/4	75	196 1/2	196 3/4	26	25 1/2	29 5/8	30 3/8

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Go'd, and Sterling Exchange

June	Sterling Exchange "Checks"	Silver		Gold	June	Sterling Exchange "Checks"	Silver		Gold
		New York	London	London			New York	London	London
7	4.62 1/4	65	31 9/16	89s. 2d.	11	4.61	65 1/8	31 13/16	89s. 5d.
8	4.61 3/8	64 3/4	31 1/2	89s. 2d.	12	4.61 1/8	65 1/8	31 3/4	89s. 5d.
9	4.61	65	31 3/4	....	13	4.61 1/8	65 1/8	31 3/4	89s. 4d.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Metal Markets

New York, June 13, 1923

The metal markets continue comparatively inactive, though sales of copper have improved in the last week. Consumers are not buying for forward delivery to the extent that they were a few months ago, as their bookings have declined somewhat owing to the fall in metal prices. Still, practically all the rolling mills and manufacturers of metal products are as busy as ever and metal is going into consumption on almost as large a scale as it was in the winter and early spring.

Copper

The improved export demand mentioned last week has continued, resulting directly in advances in copper prices in London, and indirectly in increased buying on the part of consumers in this country. Though domestic buying has been much better, it has not yet assumed the dimensions of an important buying wave. Most of the metal sold during the week has been on a 15c., delivered, basis. Yesterday afternoon, however, after a particularly encouraging lot of European orders had been placed on the books, accompanied by a good domestic inquiry, practically all producers advanced quotations to 15 1/2c., which price was paid for a substantial tonnage yesterday. Today business has been done at 15, 15 1/8 and 15 1/4c., delivered. One large producer is entirely out of the market at current levels, believing that by waiting a week or two he can sell at 15 1/2c. or better. There is no disposition, however, to rush the market, and most producers feel that for the best interest of all the price should be fairly stable. Between 15 and 16c. is thought to be a desirable level.

Consumers seem to be better provided for their July requirements than was thought, as most of the orders are for August-September delivery, with scattering business for July and October at the same price.

The export situation, on which prosperity for American copper producers depends to such a large extent, looks more favorable than for some time. We are pleased to announce that the entire 400,000,000 lb. set aside by the Copper Export Association has now been sold. Shipments will have been completed in a month or two, and then the entire export demand must be met by current production, as refinery stocks are now no larger than normal. Until the last four or five months, deliveries from the export stock were about 30,000,000 lb. per month. Latterly, they have been about half this figure. It will be recalled that all of the outstanding bonds of the Copper Export Association were retired some months ago. The Italian war stocks of copper and brass are also said to be entirely disposed of now, and other governments' stocks have been pretty well cleaned up. As already remarked, the export business for the week has been good, and at prices about one-quarter to one-eighth cent above those received for domestic orders. The increased export business of the last ten days has perceptibly lessened the pressure to sell on the part of some producers.

Lead

The official price of the American Smelting & Refining Co. continues at 7.25c., New York.

The lead market has been remarkably quiet all week, both here and in the Middle West, and is apparently just marking time, with no pressure to sell or buy, particularly around New York, where hardly a sale has been made. The current production, however, is being well absorbed by contract orders. Demand has been better from foreign consumers and more of the Mexican production is leaving the United States than was true a short time ago. Production in the United States has been somewhat less since the price dropped

from above 8c., and it is probable that the wind-up of the Pittman Act purchases of silver will have a further effect in slightly lessening production. No marked drop in production may be expected, however, with the price above 7c., which seems likely to be maintained for some time.

Most of the Middle Western producers have quoted 7c., St. Louis, all week, but 6.95c. could also be done in one direction, where the seller seems to have overstayed the market and is reported to have several thousand tons to dispose of. Consumers seem to be waiting to see if the price will not slip further before ordering in any quantity. In Chicago, most sales have been made at 7c., though quotations up to 7.10c. are heard.

Zinc

The London market has continued its decline, with the customary bad effect on business in this country. It is said that the price of iron and steel is so high in England that galvanizers are not active. Possibly the same factor is having an influence in this country, for the requirements of the galvanizing industry have recently been much less than formerly. It is also reported that the zinc coating on galvanized articles is thinner than it used to be. The statistics of the American Zinc Institute show: Stock on hand, May 1, 8,976 tons; produced in May, 47,347; shipped in May, 43,304; stock on hand May 31, 13,019. Shipped for export, 308 tons. Number of retorts operating, 86,731. The increase of 4,000 tons in stocks is not in itself of any great moment, but indicates an unsatisfactory trend and has doubtless had a further effect in weakening the market. Apparently more zinc is now being produced than the country can consume, and there is little chance of export. The price of concentrates in the Tri-State district is now said to be so high that it is unprofitable to smelt them and sell the product, so this may exert a brake on the tonnage that is put on the market. The price asked for all deliveries of Prime Western is now the same, as there is plenty of unsold June metal available. High-grade continues in good demand at 8.25@9c. as formerly.

Tin

The tin market continues extremely listless. Consumers are buying cautiously, and generally only when they need the metal, though tin platers have bought small quantities for future delivery. The position in 99 per cent metal is very tight. American deliveries this month are likely to be well under 5,000 tons, and Straits shipments about 6,000 tons. Forward tin has sold for about one-quarter cent less than spot.

Silver

The market, both abroad and here, has fluctuated within narrow limits, and no definite tendency is apparent at the moment. In London, the Indian bazaars and China have operated on a trading basis on both sides of the market, and buying orders from these sources in New York have been small. This attitude on the part of the two principal silver buyers is in itself sufficient to account for the quietness of the market.

Mexican Dollars—June 7th, 49⅝; 8th, 49⅝; 9th, 49⅝; 11th, 49⅝; 12th, 49⅝; 13th, 49⅝.

Arrivals of tin, in long tons: June 4th, Java, 75; 6th, Straits, 25; 8th, Straits, 200; China, 25; 11th, Straits, 90; China, 5; Liverpool, 100; total so far in June, 1,630.

Foreign Exchange

German marks established another new low record yesterday at 89,000 to the dollar. On Tuesday, June 12, cable quotations on francs were 6.4025c.; lire, 4.6475c.; marks, 0.001125c.; and Canadian dollars, 2⅜ per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—General market for 99 per cent grade, 27¼c. per lb.; 98 per cent, 26c. London £115.

Antimony — Chinese and Japanese brands, 6.75c. per lb. W.C.C., 7.50c. Cookson's "C" grade, spot, 10@10¼c. Consumers seem well supplied and the market is very dull.

Bismuth—$2.55 per lb. London, 10s.

Cadmium—$1 per lb. London, 5s.

Iridium—$270@$280 per oz.

Nickel—27@32c. per lb. for 99 per cent virgin metal. London, £130@£135 per long ton.

Palladium—$80@$81 per oz.

Platinum—$116 per oz. Cheaper lots reported cleaned up. London, sponge, £22½; manufactured, £24½.

Quicksilver—$68 per 75-lb. flask. San Francisco wires $67.35. London, £10.

The prices of **Cobalt, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Selenium, Tellurium, Thallium** and **Tungsten** are unchanged from prices given June 9.

Metallic Ores

Chrome, Iron Ore, Magnesite, Manganese, Molybdenum, Tantalum, Titanium, Tungsten, Uranium, Vanadium, and **Zircon Ore** are unchanged from the quotations published June 9.

Zinc and Lead Ore Markets

Joplin, Mo., June 9.—Zinc blende, per ton, high, $40.75; basis 60 per cent zinc, premium, $38; Prime Western, $38@$36; fines and slimes, $37@$35; average settling price, all zinc ores, $37.26; calamine, basis 40 per cent zinc, $18 per ton.

Lead, high, $104.50; basis 80 per cent lead, $90@$91; average settling price, all lead ore, $95.20 per ton.

Shipments for the week: Blende, 11,771; calamine, 18; lead, 1,330 tons. Value, all ores the week, $565,560.

Production of blende is being restricted by withdrawing the operation of night shifts on some of the mills. It is reported that this is necessary at some mines owing to the ore being less productive, and that it requires two ground shifts to procure enough mill ore for one shift. Others assert it is done because of lack of workmen. The output has fallen about 3,000 tons per week below the peak production two months ago.

Platteville, Wis., June 9.—Blende, basis 60 per cent zinc, $40 per ton. Lead, basis 80 per cent lead, $90 per ton. Shipments for the week: Blende, 1,041 tons; lead, 80 tons. Shipments for the year: Blende, 15,936; lead, 340 tons. Shipments for the week to separating plants: 1,795 tons blende.

Asbestos, Barytes, Bauxite, Borax, Chalk, China Clay, Diatomaceous Earth, Emery, Feldspar, Fluorspar, Fuller's Earth, Graphite, Gypsum, Limestone, Magnesite, Manjak, Mica, Monazite, Phosphate, Pumice, Pyrites, Silica, Sulphur, Talc and **Tripoli** are unchanged from the June 9 prices.

Mineral Products

Arsenious Oxide (white arsenic)—13½c. per lb. for prompt. July, 12c. Second half 1923, 11c.

Copper Sulphate — Large crystals, 5.75c.; small, 5.65c. for domestic. Imported bluestone as low as 5c.

Potassium Sulphate, Sodium Nitrate, and **Sodium Sulphate** are unchanged from quotations of June 9.

Ferro-Alloys

Ferrocerium, Ferrochrome, Ferromanganese, Ferromolybdenum, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferro-uranium, and **Ferrovanadium** are unchanged from the prices published June 9.

Metal Products

Rolled Copper—Sheets, 24.25c. base; wire, 18c.

Lead Sheets, Nickel Silver, Yellow Metal, and **Zinc Sheets** are unchanged from the prices given in the June 9 issue.

Refractories

Bauxite Brick, Chrome Brick, Chrome Cement, Firebrick, Magnesite Brick, Magnesite Cement, Silica Brick and **Zirkite** are unchanged from the June 9 prices.

The Iron Trade

Pittsburgh, June 12, 1923

From April to May the rate of steel-ingot production decreased nearly 2 per cent instead of showing an increase as expected. Pig iron production continued to increase.

Pig Iron—A merchant furnace interest, slow in getting its stack started, has bought two lots of basic iron of 2,500 tons each, paying $27.50, Valley, and making a quotable market at this level, though when forward buying is resumed a lower price is expected. Bessemer and foundry remain at $29, Valley, with little demand.

Connellsville Coke—Operators having come down to $5.50 on some good brands of coke for third-quarter, contracting has been resumed, although there is not much eagerness. One contract has been closed at $5.25. Spot furnace is steadier at $5.00, and foundry is 25c. lower, at $5.75@$6.25.

COMPANY REPORTS

Cerro de Pasco Copper Corporation

Copper; Peru

A report of the operations of the Cerro de Pasco Copper Corporation for 1922 shows an income of $5,190,158 as follows:

Income

Sales—copper, silver and gold	$17,805,584 99
Freight and passenger earnings	1,181,312.75
Dividends, interest and miscellaneous earnings	447,007.41
Inventory—copper, silver and gold—Dec. 31, 1922	3,708,404.76
	$23,142,309.91

Expenditures

Inventory—copper, silver and gold—Dec. 31, 1921	$4,357,182.63
Operating, smelting, shipping, refining, and administration	10,008,009.85
Custom ores	3,010,687.51
United States and foreign taxes	576,271.92
Balance—to consolidated surplus account	5,190,158.00
	$23,142,309.91

Consolidated surplus account is as follows:

Adjustment of investments in subsidiary companies	$10,830.13
Depreciation of plant and equipment	1,026,222.87
Depletion of metal and coal mines	3,295,474.50
Interest on 10-year convertible sinking fund 8 per cent gold bonds	595,360.00
Balance Dec. 31, 1922, per consolidated balance sheet	302,606.80
	$5,230,494.30
Balance—Dec. 31, 1921	$40,336.30
Balance of income—Jan. 1, 1922, to Dec. 31, 1922, from consolidated income and expenditures account	5,190,158.00
	$5,230,494.30

Balance sheet as of Dec. 31, 1922, is given as follows:

Assets

Fixed:		
Metal and coal mines and mining leases	$32,761,827.78	
Less reserve for depletion	23,394,343.05	$9,367,484.73
Plant, equipment, concession and construction	$28,389,560.11	
Less reserve for depreciation	6,526,041.38	21,863,518.73
Investments		
Miscellaneous investments		1,239,256.50
Deferred		
Deferred charges in suspense	$665,147.76	
Bond sinking fund (in hands of trustee for bond redemption)	764,369.47	1,429,517.23
Current		
Supplies for construction and stock	$3,714,734.75	
Merchandise inventory	447,500.86	
Accounts receivable	1,760,611.50	
Copper, silver and gold inventory	3,708,404.76	
U. S. Treasury 3¾ per cent and 4¼ per cent certificates	2,000,000.00	
Cash at bankers and on hand	4,629,610.72	16,260,862.59
		$50,160,639.78

Liabilities

Capital			
Capital stock—without nominal or par value		$6,200,000.00	
	Shares		
Authorized	1,240,000		
Unissued	327,188		
Outstanding	912,812		
Capital surplus—stockholders' equity in owned properties		32,981,486.36	
Bonds—ten-year convertible sinking fund 8 per cent gold bonds, maturing Jan. 1, 1931			
Authorized and issued	$8,000,000.00		
Less redeemed and converted	878,000.00		
Outstanding		7,122,000.00	$46,303,486.36
Deferred			
Reserve for United States and New York state taxes		$583,834.61	
Deferred credits in suspense		39,377.61	623,212.22
Current			2,931,334.40
Surplus			
Surplus—per consolidated surplus account			302,606.80
			$50,160,639.78

Utah Copper Co.

A report of the operations of the Utah Copper Co. for the first quarter 1923 follows:

The copper contained in concentrates for the quarter is given below:

First Quarter 1923

	Pounds
January	11,697,822
February	10,160,296
March	12,630,955
Total	34,489,073
Average monthly production	11,496,357

The net production of marketable copper derived from this gross output, after allowing for smelter deductions, was 33,103,190 lb., compared with 31,495,654 lb. for the previous quarter.

During the quarter the Arthur plant treated 1,380,400 dry tons and the Magna plant 394,300 dry tons, a total for both plants of 1,774,700 dry tons, or an increase of 126,100 tons compared with the previous quarter.

The average grade of ore treated at the mills was 1.17 per cent copper and the average recovery 83 per cent, compared with 1.25 per cent and 79.27 per cent, respectively, for the previous quarter.

The average cost per net pound copper produced, including all fixed and general charges except depreciation and federal tax reserves, and after crediting gold, silver and miscellaneous earnings, was 8.825c. Gold and silver and miscellaneous earnings amounted to 1.34c. per pound of copper.

The following tabulation shows the financial results of the company's operations:

	First Quarter 1923
Net profit from copper production only	$1,797,521.47
Miscellaneous income, including gold and silver	443,590.20
Total income	$2,241,111.67

Earnings for the first quarter are computed on the basis of 15.595c. per lb. for copper.

A quarterly distribution to stockholders of $1 per share was made on March 31, 1923, and amounted to $1,624,490.

The total capping removed during the quarter was 505,986 cu.yd., an average of 168,662 cu.yd. per month, compared with 416,896 cu.yd. and 138,965 cu.yd., respectively, for the previous quarter.

The ore-delivery department transported a total of 1,945,668 tons of ore, being an average of 21,619 tons per diem, as compared with 1,766,838 tons and 19,205 tons, respectively, for the previous quarter.

The Bingham & Garfield Ry. Co. transported a total of 260,395 tons of freight, or an average of 2,893 tons per diem.

Ray Consolidated Copper Co.

Copper; Ray, Ariz.

A report of the Ray Consolidated Copper Co. covering the first quarter of 1923 states that the total net production of copper from all sources was 14,009,441 lb., compared with a total of 12,249,695 lb. for the preceding quarter:

First Quarter, 1923

	Pounds
January	4,382,657
February	4,253,056
March	5,373,728
Total	14,009,441
Average monthly production	4,669,814

There were milled 582,600 tons, dry weight, of ore averaging 1.59 per cent copper, an average daily tonnage of 6,473 tons, compared with an average of 5,399 tons per day

for the previous quarter. The mill recovery was 78.26 per cent of the total copper contained in concentrating ores, compared with 79.53 per cent for the previous quarter.

The average cost per net pound of copper produced was 11.99c., compared with 11.30c. for the previous quarter. Both figures include all general expenses other than depreciation and federal tax reserves, and also take into account miscellaneous income and the value of gold and silver recovered. The increase in costs for this quarter as compared to those of the previous one was due in large part to an increase in wages, which became effective in the latter of the quarter, coupled with a considerable amount of extraordinary expense incurred in reopening and resuming operations at the Number One mine and charged to operations.

The financial results of operations for the quarter are stated as follows:

First Quarter, 1923	
Operating profit	$458,988.50
Miscellaneousi ncome and gold and silver	29,435.88
Total income	$488,424.38

The average carrying price of copper for the quarter was 15.476c.

Chino Copper Co.

Hurley, New Mexico

A statement of the operations of the Chino Copper Co. for the first quarter of 1923 follows:

Four regular sections of the mill at Hurley, together with a proportionate number of ball mills in the fine-grinding section, were in operation during the quarter. These correspond in capacity to about two-thirds of normal tonnage for the entire plant, but the actual tonnage treated did not reach that percentage, because of interferences due, principally, to necessary additions and repairs of concentrating and other facilities. Progress in making these betterments, as well as that in connection with the installation of new flotation equipment, has not been as rapid as expected, because of limited working forces. Satisfactory advances are being made in the application of methods for treatment of partly oxidized ores in the pilot plant, referred to in previous reports.

The net production of refined copper, after allowing for smelter deductions, was 13,356,764 lb., as stated below, compared to 12,545,865 lb. for the preceding quarter.

First Quarter, 1923	Pounds
January	4,440,237
February	3,768,330
March	5,148,197
Total	13,356,764
Average monthly production	4,449,191

The total dry tonnage of ore treated for the quarter was 704,295 tons, an average of 7,825 tons per day, the average grade being 1.51 per cent copper. The comparative figures for the preceding quarter were 6,444 tons per day, containing an average of 1.61 per cent copper. The average gross recovery of copper contained in concentrates for the quarter was 19.72 lb. per ton of ore treated, as compared to 21.96 lb. per ton for the previous quarter.

The cost per pound of net copper produced from mill operations was 12.50c., compared with 11.38c. for the quarter ended Dec. 31, 1922. These costs include all operating and general charges of every kind, excepting depreciation and reserves for federal taxes, and also include credit for gold and silver values and miscellaneous revenues.

The following tabulation shows the financial results of operations exclusive of depreciation or Federal tax charges:

First Quarter, 1923	
Operating gain	$388,752.46
Miscellaneous income, including precious metals	16,859.38
Operating gain for quarter	$405,611.84

The above figures are based on an average of 15.44c. per lb. for copper, compared with 13.81c. for the quarter ended Dec. 31, 1922.

At the mines three additional steam shovel crews were put in service during the quarter, making twelve in all.

Amparo Mining Co.

Gold, Silver; Mexico

A report of the operations of the Amparo Mining Co. for 1922 shows a profit of $477,759, according to the following income account:

Cost of mining ore and development		$460,638.75
Transportation of ore to mill		36,725.62
Cost of milling		273,383.20
Marketing bullion and concentrates		67,892.30
Taxes, Mexico		160,348.89
Military protection and watchman		19,861.27
Prospecting		7,050.20
Diamond-drill work		16,905.47
Damages and losses		5,321.32
Church service		2,238.27
General expenses, administration and office		89,620.00
Silver bullion purchased		62.33
Expenses Canada operation 1922		28,751.48
Miscellaneous expenses		660.07
Depletion of mineral resources	$121,248.05	
Depreciation for year	53,893.48	
		175,141.53
		$1,344,600.70
Net profit on operation		521,912.68
		$1,866,513.38

Income

Sale of bullion and concentrates		$1,582,100.77
Premiums and interest		5,747.30
Gain in shipping expenses and taxes 1921		1,266.24
Profit on sale silver certificates		271,286.09
Miscellaneous income		6,112.98
		$1,866,513.38
Profit on operation		521,912.68
Miscellaneous expenses	$17,571.60	
Less, interest on deposits	5,585.70	
	$11,985.90	
Taxes paid	$53,750.03	
Less interest on investments	21,582.56	
	32,167.47	
		44,153.37
Net profit on operations		$477,759.31

Balance sheet as of Dec. 31, 1922, is given as follows:

Plant: Land, buildings, machinery and equipment		$2,373,112.78
Available		
Cash	$243,945.68	
Silver certificates	30,242.22	
Liberty bonds	64,994.50	
Accounts receivable, Mexico	74,063.29	
U. S. Certificates of Indebtedness	50,000.00	
Material and supplies on hand	178,530.73	
Ore on hand and in transit	224,546.58	
Investments of Contingent Fund	750,216.98	
		1,616,539.98
Miscellaneous		$326,792.54
		$4,316,445.30

Liabilities

Accounts payable, Mexico		$10,903.00	
Exchange		225.35	
Shipping and selling		6,881.56	
Taxes, Mexico		16,327.03	
Depletion of mineral resources		923,313.16	
Reserves			1,740,778.66
			$2,575,666.64
Capital stock	$2,996,800.00		
In treasury	996,800.00		
		$2,000,000.00	
Surplus, Jan. 1, 1922	$1,041,018.43		
Less contingent fund. $50,000.00			
Canada operation charged off	77,059.91		
	127,059.91		
	$913,958.52		
Less dividends	340,000.00		
	$573,958.52		
Net profit 1922	477,759.31		
	$1,051,717.83		
Less reserves for property and development	700,000.00		
	$351,717.83		
Contingent fund.... $200,000.00			
Insurance fund, Mexican office.... 17,948.81			
Mexican office fire insurance fund... 6,000.00			
	$223,948.81		
		$575,666.64	
			$2,575,666.64

Production amounted to 1,606,668 oz. of silver and 37,188 oz. of gold. Total mined and milled during 1922 was 157,465 metric tons, being a daily average of 432 metric tons averaging 351 grams silver and 7.6 grams gold. The average extraction was 93.28 per cent. Cost per ton was $7.54.

Arizona Copper Co.

A report of the operations of the Arizona Copper Co. for the period from Oct. 1, 1922, to March 31, 1923, follows:

	£	s.	d.
Dividends for the half year on the company's holding in the Phelps Dodge Corporation, discount received on treasury bills, bank interest, and transfer fees	25,094	0	0
Expenses for the half year	2,662	17	2
Surplus	22,431	2	10
Balance at the credit of profit-and-loss account at Sept. 30, 1922	20,389	4	9
Total	42,820	7	7
Transferred from reserve	50,000	0	0
Total	92,820	7	7

From this balance the directors recommend that a dividend on the ordinary shares be declared for the period from Oct. 1, 1922, to March 31, 1923, of 1s. per share, free of tax, absorbing £75,994, 16s., and that the balance £16,825, 11s. 7d., be carried forward.

Iron-Ore Production Increased Greatly Last Year

Considerably more iron ore was mined in 1922 than in 1921, according to the Interior Department. The Chattanooga and Birmingham districts made gains of 126 per cent and 73 per cent, respectively, and the Lake Superior district made a gain of 58 per cent. The Adirondack district was the only one that mined less ore than in 1921. The average value per ton of iron ore at the mines in 1922 was $3.12, which is 25c. less than in 1921. The stocks of iron ore at the mines at the end of 1922 amounted to 10,524,279 gross tons, a decrease of 24 per cent from those in 1921.

Iron Ore Mined in the United States in 1921 and 1922

State	In Gross Tons 1921	1922	Percentage of Increase or Decrease in 1922
Alabama	2,876,141	5,234,568	+ 82
California	2,064	3,204	+ 55
Colorado	3,823	513	— 87
Georgia	5,556	24,149	+ 335
Idaho	799	200	— 75
Massachusetts	4,100	.....	...
Michigan	7,075,204	10,453,578	+ 48
Minnesota	17,811,325	28,768,960	+ 62
Missouri	36,550	58,408	+ 60
Montana	26,174	21,726	— 17
Nevada	268	51	— 81
New Jersey	58,589	90,359	+ 54
New Mexico	110,528	118,038	+ 7
New York	469,988	444,381	— 5
North Carolina	2,583	17,279	+ 569
Pennsylvania	146,649	780,836	+ 432
Tennessee	25,709	156,464	+ 509
Texas	131	.....	...
Utah	60,773	15,018	— 75
Virginia	74,021	30,971	— 58
Wisconsin	257,014	577,024	+ 125
Wyoming	234,701	332,800	+ 42
	29,282,690	47,128,527	+ 61

Estimates Indicate Copper Stocks Decreased Again in May

No official figures as to copper shipments, stocks, or refinery production are now given out, but estimates have been made in New York which are probably not far from the truth. According to these reports, exports and domestic shipments in May amounted to 190,000,000 lb., compared to 192,000,000 to 195,000,000 lb. in April, 210,000,000 to 215,000,000 lb. in March, 175,000,000 to 180,000,000 lb. in February, and 207,000,000 lb. in January. The total shipments estimated for the first five months of the year are therefore about 980,000,000 lb., an average of about 195,000,000 lb. per month, which is the largest amount of copper consumed in any peace-time period in history.

The refinery output in May was said to be about 185,000,000 lb., so that stocks of refined copper, much of which is probably already sold, decreased about 5,000,000 lb. for the month, and are now little above 200,000,000 lb. Refinery output in April was thought to be about 167,000,000 lb.; in March, 190,000,000 lb.; in February, 160,000,000 lb.; and in January, 165,000,000 lb.

Facts for the Stockholder

XIX—Calumet & Hecla Mining Co.

THE CALUMET & HECLA Mining Co. was incorporated in Michigan, in 1871, as a consolidation of the Calumet, Hecla, Portland, and Scott mining companies. In 1900 its charter was renewed for thirty years, and in 1905 the charter was amended, making the corporation a holding company, as well as a mining and smelting company. It has also secured control of numerous other mining companies and mineral tracts, through the organization of subsidiary companies or by the purchase of stock in previously organized corporations.

In addition to absorbing the Tamarack, Laurium, Frontenac, Manitou, Dana, and St. Louis mining companies, it has acquired stock in other mining properties as follows: 99,168 shares Ahmeek Mining Co.; 41,000 Allouez Mining Co.; 41,500 Centennial Copper Mining Co.; 28,785 Cliff Mining Co.; 35,000 Isle Royale Copper Co.; 152,977 La Salle Copper Co.; 33,560 Osceola Consolidated Mining Co.; 50,100 Superior Copper Co.; 42,602 White Pine Copper Co. common; 10,000 White Pine Copper Co. preferred; 1,000 Great Lakes Transit Corporation preferred; 1,000 Great Lakes Transit Corporation common; and 65,000 Copper Canyon Mining Co.

Calumet & Hecla owns and controls over 160,000 acres of land, about half of which is in Keweenaw County, Mich., the rest being in Houghton and Ontonagon counties. With its subsidiaries it has a shore line of about 34 miles on Lake Superior, Lac La Belle, and Torch Lake. On the company's lands are numerous towns, having an aggregate population of over 60,000, including employees and others depending upon the operations of the company and its allied interests.

The Calumet & Hecla mine proper is included in a tract of about 2,800 acres covering the Calumet conglomerate bed in which the original mine is opened. Parallel mines have been developed in the Osceola amygdaloid and the Kearsarge amygdaloid beds. The conglomerate bed is 5 to 25 ft. wide, with an average of about 13 ft. During the last six years, the yield of copper per ton of ore treated has been: 28.78 lb. in 1917, 28 in 1918, 29.61 in 1919, 35.10 in 1920, 37.75 in 1921, and 47.08 lb. in 1922. This property is opened by eleven shafts, four of which are about 8,000 ft. deep, inclined measurement. The Red Jacket shaft is vertical, having a depth of 4,900 ft. There are about 200 miles of underground workings. The conglomerate is opened for a length of about two miles along the outcrop.

The Osceola lode is opened over 11,000 ft. along the strike, by six shafts ranging in depth from 1,460 to 3,380 ft., and the underground development work aggregates about 35 miles. Average width of the lode is about 35 ft. The yield of copper per ton of ore treated is from 12 to 15.7 lb.

Total production of copper in millions of pounds has been as follows: 74 in 1911, 68 in 1912, 45 in 1913, 54 in 1914, 73 in 1915, 77 in 1916, 77 in 1917, 68 in 1918, 53 in 1919, 57 in 1920, 15 in three months' operation in 1921, and 40 in nine months' operation in 1922.

Production costs per pound of copper before depletion and depreciation have been as follows: 8.52c. in 1911, 9.86c. in 1912, 14.25c. in 1913, 11.35c. in 1914, 9.33c. in 1915, 11.63c. in 1916, 13.01c. in 1917, 15.71c. in 1918, 16.68c. in 1919, 15.34c. in 1920, 13.47c. in 1921, and 9.75c. in 1922.

Capitalization consists of 100,000 shares of stock, par value $25. After June 23, 1923, capitalization will consist of 800,000 shares of stock, par value $25. There is no funded debt. Earnings per share on the former basis are estimated as follows: $95.30 in 1917, $49.49 in 1918, $13.67 in 1919, a loss equivalent to $38.23 a share in 1920, a loss of $14.91 in 1921, and a loss of $9.37 in 1922.

The dividend record is as follows: $24 a share in 1911, $42 in 1912, $32 in 1913, $10 in 1914, $50 in 1915, $75 in 1916, $85 in 1917, $55 in 1918, $10 in 1919, $5 in 1920, nothing in 1921, and $10 in 1922. A dividend of $7 was paid on March 15, 1923, and $10 per share on June 15, 1923.

On Dec. 31, 1922, total current assets were $14,307,809, with current liabilities of $1,060,790, leaving net working capital at about $13,247,000.

Price range of the stock on the Boston Stock Exchange has been: High, $1,000 in 1907; low, $210 in 1921; closing price $370 on June 12, 1923. INVESTIGATOR.

MINING STOCKS

Week Ended June 9, 1923

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Ahmeek	Boston	70	70	70	Mar. 23, Q	$1.00
Alaska-Br. Col.	N. Y. Curb	2¼	2	2¼		
Allouez	Boston	22½	22½	22½	Mar. '19	1.00
Anaconda	New York	45⅝	44⅜	45⅜	Apr. '23, Q	0.75
Arcadian Consol.	Boston	1⅛	1⅛	1⅛		
Ariz. Com'l	Boston	10½	10½	10½	Oct. '18, Q	0.50
Calaveras	N. Y. Curb			2⅜		
Calumet & Arizona	Boston	53⅜	52¼	52⅜	Mar. '23,	1.00
Calumet & Hecla	Boston	381	371	373	Mar. '23, Q	7.00
Centennial	Boston			9½	Dec. '18, SA	1.00
Cerro de Pasco	New York	43½	42½	43	May '23,	1.00
Chile Copper	New York	27⅜	26⅛	26⅞	Mar. 23,	0.62½
Chino	New York	23⅜	22	23	Sept. '20, Q	0.37½
Con. Coppermines	N. Y. Curb	3¼	3	3		
Copper Range	Boston	34	32½	33¼	May '23, Q	1.00
Crystal Copper	Boston Curb	1½	1½	1½		
Davis-Daly	Boston	3 1/16	2⅜	3⅜	Mar. '20, Q	0.25
East Butte	Boston	7⅛	7⅛	7⅛	Dec. '19, A	0.50
First National	Boston Curb	*46	*37	*46	Feb. '19, SA	0.15
Franklin	Boston	*40	*30	*40		
Gadsden Copper	N. Y. Curb			*80		
Granby Consol.	New York	24	23	24	May '19, Q	1.25
Greene-Cananea	New York	23¼	23⅛	23½	Nov. '20, Q	0.50
Hancock	Boston			2½		
Howe Sound	N. Y. Curb	3⅜	3⅜	3⅜	Jan. '21, Q	0.05
Inspiration Consol.	New York	33½	32	32⅜	Apr. '23, Q	0.50
Iron Cap	Boston Curb	5⅜	4	5	May 23, K	0.15
Isle Royale	Boston	24	24	24	Mar. '23, Q	0.50
Kennecott	New York	37⅜	35½	36⅛	Apr. '23, Q	0.75
Keweenaw	Boston	2⅜	2⅜	2⅜		
Lake Copper	Boston	3	2⅜	2⅜		
Magma Copper	New York	34	32½	32½	Jan. '19, Q	0.50
Mason Valley	N. Y. Curb	1⅜	1⅜	1⅜		
Mass Consolidated	Boston			1⅜	Nov. '17, Q	1.00
Miami Copper	New York	25⅜	25⅛	25⅜	May '23, Q	0.50
Michigan	Boston	1⅜	1⅜	1⅜		
Mohawk	Boston	51	49	51	Mar. '23, Q	1.00
Mother Lode Coa	New York	10⅜	9⅜	9⅜	Mar. '23, K	0.50
Nevada Consol.	New York	14¼	13⅜	13⅜	Sept. '20, Q	0.25
New Cornelia	Boston	18⅛	17⅞	18⅛	May '23, Q	0.25
North Butte	Boston	7¼	7⅛	7⅛	Oct. '18, Q	0.25
Ohio Copper	N. Y. Curb	*67	*55	*59		
Old Dominion	Boston	22½	22½	22½	Dec. '18, Q	1.00
Osceola	Boston	33	31	33	Mar. '23, K	1.00
Phelps Dodge	Open Mar.	†185	†175		Apr. '23, Q	1.00
Quincy	Boston	32	30	32	Mar. '20, Q	1.00
Ray Consolidated	New York	13¼	12⅛	13⅛	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	1⅛	1⅛	1⅛		
St. Mary's Min. Ld.	Boston	40	39⅛	40	Mar. '23, K	3.00
Seneca Copper	New York	8⅞	8⅛	8⅜		
Shannon	Boston	*70	*70	*70	Nov. '17, Q	0.25
Shattuck Arizona	New York			7⅛	Jan. '20, Q	0.25
South Lake	Boston	*12	*10	*12		
Superior & Boston	Boston	1⅜	1⅛	1 3/16		
Tenn. C. & C. cfs.	New York	10	9⅜	9⅜	Apr. '23, Q	0.25
Tuolumne	Boston	*38	*31	*31	May '13,	0.10
United Verde Ex.	N. Y. Curb	34	34	34	May '23, Q	1.00
Utah Consol.	Boston	1⅜	1⅛	1⅜	Sept. '18,	0.25
Utah Copper	New York	65⅛	64⅛	65⅛	Mar. '23, Q	1.00
Utah Metal & T.	Boston	*90	*90	*90	Dec. '17,	0.30
Victoria	Boston			1		
Winona	Boston	*80	*80	*80		
Wolverine	Boston	8	7⅛	8		
NICKEL-COPPER						
Internat. Nickel	New York	15⅜	14	14⅛	Mar. '19,	0.50
Internat. Nickel pfd.	New York	82⅛	79⅛	82⅜	May '23, Q	1.50
LEAD						
Carnegie Lead & Zinc	Pittsburgh	3⅛	3⅛	3⅛		
National Lead	New York	121⅛	120½	121⅛	Mar. '23, Q	2.00
National Lead pfd.	New York	111⅛	108¾	111⅛	Mar. '23, Q	1.75
St. Joseph Lead	New York	19⅛	19⅛	19⅛	Mar. '23, Q,X	0.50
ZINC						
Am. Z. L. & S.	New York	12⅜	12⅛	12⅜	May '20,	1.00
Am. Z. L. & S. pfd.	New York	45	43	43	Nov. '20, Q	1.50
Butte C. & Z.	New York	7⅛	6⅞	7⅛	Mar. '23,	0.50
Butte & Superior	New York	25	22⅝	25	Mar. '23, Q	0.50
Callahan Zn-Ld	New York	7⅛	6⅜	6⅜	Dec. '20, Q	0.50
New Jersey Zn.	N. Y. Curb	160	158	160	May '23, Q	2.00
United Zinc	N. Y. Curb			1		
Yellow Pine	Los Angeles	*65	*61	*62	Sept. '20, Q	0.03
SILVER						
Alvarado	N. Y. Curb	6⅛	6⅛	6⅛		
Batopilas Mining	New York	⅛	⅛	⅛	Dec. '07, I	0.12½
Beaver Consol.	Toronto	*35	*33	*35	May '20, K	0.03
Candelaria	N. Y. Curb	*7	*6	*7		
Castle-Trethewey	Toronto	*25	*24½	*25		
Coniagas	Toronto	3.00	2.80	2.80	May '21, Q	0.12½
Crown Reserve	Toronto	*59	*56½	*56½	Jan. '17,	0.05
Hilltop-Nev.	N. Y. Curb.	1⅛	1	1		
Kerr Lake	N. Y. Curb	2⅜	2⅜	2⅜	Apr. '23, Q	0.12½
La Rose	Toronto	*35	*31	*32	Apr. '22,	0.10
McKinley-Dar.-Sav.	Toronto	*19	*18	*18	Oct. '20, Q	0.03
Mining Corp. Can.	Toronto	2.80	2.75	2.75	Sept. '20, Q	0.12½
Nipissing	N. Y. Curb	5⅛	5⅛	5⅛	Apr. '23, Q	0.15
Ontario Silver	New York	5⅛	5⅛	5⅛	Jan. '19, Q	0.50
Temiskaming	Toronto	*40	*39	*40	Jan. '20, K	0.04

Stock	Exch.	High	Low	Last		Last Div.
GOLD						
Alaska Gold	New York			⅜		
Alaska Juneau	New York	1⅛	1	1⅛		
Boundary Red M.	N. Y. Curb	*30	*20	*20		
Carson Hill	Boston	6½	6⅛	6⅛		
Cresson Consol. G.	N. Y. Curb	3⅛	2⅛	2⅛	Apr. '23 Q	0.10
Dome Mines	New York	39½	36⅛	38	Apr. '23, Q	0.50
Golden Cycle	Colo. Springs	1.08	1.05	1.06	Dec. '22, Q	0.02
Hollinger Consol.	Toronto	13.05	12.10	13.05	May '23, M	0.05
Homestake Mining	New York	65	63½	65	May '23, M	0.50
Kirkland Lake	Toronto	*42	*40½	*40½		
Lake Shore	Toronto	3.60	3.60	3.60	May '23, Q	0.02
McIntyre-Porcupine	New York	19⅛	17⅛	18⅛	May '23, Q	0.25
Portland	Colo. Springs	*39½	*37½	*37½	Oct. '20, Q	0.01
Teck-Hughes	N. Y. Curb	1 1/16	1⅛	1 1/16		
Tom Reed	Los Angeles	*75	*68½	*69	Dec. '19,	0.02
United Eastern	N. Y. Curb	2	1⅛	1⅛	Apr. '23, Q	0.15
Vipond Cons.	Toronto	*53	*51	*52½		
White Caps Mining	N. Y. Curb	*7	*5	*5		
Wright-Hargreaves	Toronto	3.25	3.10	3.25	Apr. '23,	0.02½
Yukon Gold	N. Y. Curb	1⅛	1 1/16	1 1/16	June '18,	0.02½
GOLD AND SILVER						
Boston-Mont. Corp.	N. Y. Curb	*15	*14	*14		
Cons. Virginia	San Francisco	9½	9½	9½		
Continental Mines	N. Y. Curb	5⅛	4⅞	5⅛		
Dolores Esperanza	N. Y. Curb	1⅜	1 1/16	1 1/16	Apr. '23	0.05
Jib Consol.	N. Y. Curb			*92		
Tonopah Belmont	N. Y. Curb	*90	*84	*85	Apr. '23, Q	0.05
Tonopah Divide	N. Y. Curb	*56	*40	*49	May 23	0.10
Tonopah Extension	N. Y. Curb	1 1/16	1⅛	1⅛	Jan. '23, Q,X	0.10
Tonopah Mining	N. Y. Curb	1 1/16	1⅛	1 1/16	Apr. '23, Q	0.07½
Unity Gold	N. Y. Curb	4⅛	4⅛	4⅛		
West End Consol.	N. Y. Curb	1	*93	*97	Mar. '23, Q	0.05
SILVER-LEAD						
Bingham Mines	Boston	16⅛	16⅛	16⅛	Sept. 19, Q	0.25
Cardiff M. & M.	Salt Lake	*60	*53	*60	Dec. '20,	0.15
Chief Consol.	Boston Curb	4⅛	4	4	May '23, Q	0.10
Columbus Rexall	Salt Lake	*68	*58	*66	Aug. '22,	0.03
Consol. M. & S.	Montreal	26⅛	25⅛	25⅛	Oct. '20, Q	0.62½
Federal M. & S.	New York	7⅛	5	6	Jan. '09,	1.50
Federal M. & S. pfd.	New York	41⅛	34½	40	Mar '23, Q	1.75
Florence Silver	Spokane	*38	*38	*38	Apr. '19, Q,X	0.01½
Hecla Mining	N. Y. Curb	7⅜	7⅛	7⅛	Mar. '23,	0.25
Iron Blossom Con.	N. Y. Curb	*30	*29	*30	Apr. '22, Q	0.02½
Marsh Mines	N. Y. Curb	*14	*14	*14	June '21, I	0.02
Park City	Salt Lake	3.15	3.15	3.15	Apr. '23,	0.12½
Park Utah	N. Y. Curb	3⅛	3	3⅛	Apr. '23	0.15
Prince Consol.	Salt Lake	*5⅛	*4½	*4½	Nov. '17,	0.02½
Silversmith	Spokane	*39½	*38	*38	Apr. 23,	0.01
Simon Silver Lead	N. Y. Curb	*34	*30	*34		
Snow Storm Silver-L	N. Y. Curb	1	*98	1		
Tamarack-Custer	Spokane	1.35	1.30	1.30	Jan. '21, K	0.04
Tintic Standard	Salt Lake	3.20	3.00	3.17½	Dec. '22, Q,X	0.10
Utah-Apex	Boston	4	3⅛	3⅛	Nov. '20, K	0.25
IRON						
Bethlehem Steel	New York	53⅛	51⅛	53⅛	Apr. '23, Q	1.25
Char. Iron	Detroit			1		
Char. Iron, pfd	Detroit			2⅛		
Colorado Fuel & Iron	New York	35⅛	32⅛	34½	May '23, Q	2.00
Col. Fuel & Iron pfd.	New York			102	Feb. '23, Q	2.00
Gt. North'n Iron Ore	New York	29	28½	28⅛	Apr. '23	1.00
Inland Steel	N. Y. Curb			46½	June '23 Q	0.62½
Mesabi Iron	N. Y. Curb			9		
Replogle Steel	New York	19⅛	19	19		
Republic I. & S.	New York	52⅛	48⅛	50⅛	May '23	1.50
Republic I. S. pfd.	New York	95⅛	94⅛	94⅛	Apr. '23	1.75
Sloss-Sheffield S. & I.	New York	50⅛	50	50	Feb. '21	1.50
Sloss-Shef. S.&I. pfd.	New York	80	80	80	Apr. '23	1.75
U. S. Steel	New York	98	95⅛	96⅛	Mar. '23, Q	1.25
U. S. Steel pfd.	New York	118	117⅛	117⅛	May '23	1.75
Virginia I. C. & C.	New York	59	59	59	Jan. '22	1.50
Virginia I.C.&C.pfd.	New York			83	Jan '23	2.50
VANADIUM						
Vanadium Corp.	New York	34	31⅛	33⅛	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp.	Montreal	62⅛	60	62⅛	Apr. '23 Q	1.50
Asbestos Corp. pfd.	Montreal	83⅛	83	83	Apr. '23 Q	1.75
SULPHUR						
Freeport Texas	New York	14	13⅜	13⅞	Nov. '19, Q	1.00
Texas Gulf	New York	60⅜	59⅛	60	May '23, Q	1.50
PLATINUM						
So. Am. Gold & P.	N. Y. Curb			3		
MINING, SMELTING AND REFINING						
Amer. Metal	New York	46⅛	46	46⅛	Mar. '23, Q	0.75
Amer. Metal pfd.	New York			114	Mar. '23, Q	1.75
Amer. Sm. & Ref.	New York	63⅛	59⅛	62⅜	Mar. '21, Q	1.00
Amer. Sm.& Ref. pfd	New York	97⅜	97⅛	97⅜	Mar. '23 Q	1.75
U. S. Sm. R. & M.	New York	30⅛	30⅛	30⅛	Jan. '21, Q	0.50
U.S. Sm.R.& M. pfd.	New York	44⅛	43⅞	44⅛	Apr. '23 Q	0.87½

*Cents per share. †Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra.

Toronto quotations courtesy Arthur E. Moysey; Spokane, Pohlman Investment Co; Salt Lake, Stock and Mining Exchange; Los Angeles, Chamber of Mines and Oil; Colorado Springs, Colorado Springs Stock Exchange.

NEW MACHINERY AND INVENTIONS

Automatic Starters for Synchronous Motors

Automatic control of the starting of synchronous-type motors is making possible the use of this type of motor to a greater extent, because the manual starting is apparently a complicated procedure which takes considerable time and effort on the part of the attendant. By the use of controllers recently designed by the Cutler-Hammer Manufacturing Co., of Milwaukee, Wis., the starting of a synchronous motor is as simple as for any other type, a push button station being the only part of the apparatus which the attendant need operate.

Most all modern synchronous motors are supplied with squirrel-cage windings for starting purposes, and in addition to shifting the connections from the low voltage to the high voltage transformer taps it is necessary to connect the field winding of the motor to the d.c. exciter at the proper time.

Synchronous motors are usually of a size which requires a starting compensator of greater capacity than the average manual size, and are in many cases wound for high voltages. For these reasons, also, automatic control with magnetic contactors is preferable. Oil switches are used, one for connecting the motor to the starting transformer, and another to connect the motor to the line. After the motor is up to speed and the field switch closed, the starting switch must be opened and running switch closed. If these operations are not carried out properly, various troubles arise, such as high peak currents, breaking down of the insulator, which makes the automatic starter with its simple push button control so attractive.

In one recent installation in a pumping station, the "start" and "stop" push button station was located one mile distant. For automatic starting of a synchronous motor driving a pump, a float switch may be employed which will start the motor at low level and stop it when a pre-determined high level is reached. On a closed system, a pressure regulator may be used in place of the float switch for accomplishing the starting and stopping, being connected in the pilot circuit to the main magnetic switch of the automatic starting panel. With some installations a magnetic clutch is used between motor and driven machine, which remains disengaged during the period that the motor is getting up to speed and synchronizing.

The Straub Manufacturing Co., 507 Chestnut St., Oakland, Calif., has contracted with the Charleston Hill National Mining Co., of Winnemucca, Nev., for a complete amalgamation and concentration plant, which inclues two No. 2 Straub mills.

INDUSTRIAL NOTES

W. C. Finely, erecting engineer for the Pelton Water Wheel Co., is at Ocean Falls, B. C., where he is installing a 6,300-hp. Pelton double-overhung reaction turbine at the power plant of the Pacific Mills, Ltd. The company has also contracted with the Pacific Power & Light Co., for reconstructing the No. 4 turbine in its Walla Walla River plant, near Milton, Ore.

The Ruggles-Coles Engineering Co., 50 Church St., New York, reports recent sales of sixteen Ruggles-Coles driers to twelve different companies in six different states. These driers were intended for stone, ore, coal, sand, clay, carbon and coke. Two special coolers were also sold to the California Cyanide Co., of Los Angeles.

The Uehling Instrument Co., of Paterson, N. J., which manufactures CO_2 recorders and draft and vacuum gages, has just made two important agency appointments — namely, Amsler-Morton Co., Fulton Building, Pittsburgh, Pa., for western Pennsylvania, and John A. MacDowell, 2039 Railway Exchange Building, St. Louis, Mo., for eastern Missouri and southern Illinois. H. R. N. Johnson, who formerly represented the Uehling Instrument Co. in Minnesota and the Dakotas, has joined the W. P. Nevins Co., 120 South Ninth St., Minneapolis, Minn., which company is now the official Uehling representative in the territory mentioned.

The Link-Belt Co., of Chicago and Philadelphia, announces that L. M. Dalton has succeeded E. J. Burnell as manager of the Boston branch office. Mr. Burnell resigned his post to enter business for himself. In the future the address of the Link-Belt Cleveland office will be No. 329 Rockefeller Building. This is the same building under a new name.

The B. F. Sturtevant Co., Hyde Park, Boston, Mass., has purchased the plant of the Wisconsin Engine Co., makers of Corliss pumping engines at Corliss, Wis. The plant covers ten acres. Shipping facilities are ample. The new plant will be under the same direction as the other factories at Hyde Park, Galt, San Francisco, and Philadelphia with Ex-Governor Foss as president. Harry W. Page has been selected as general manager and will be in entire charge of the Wisconsin plant.

The Federal Zinc & Lead Co., Ltd., announces the removal of its Montreal office to Room 602, Drummond Building, Montreal, Que.

The new improved form of gelatin recently placed on the market by the Atlas Powder Co. is stated by the company to be giving excellent results, not only in its all-around efficiency as an explosive, but in respect to the negligible amount of fumes evolved. One foreman advises that they have cut down the number of sticks to the hole and cut out three fans, as gas does not bother. An engineer on a large tunnel operation reports that his men can return to work in twelve to eighteen minutes, while with old style gelatin it required at least thirty minutes before they could go back. The manufacturer of this new explosive claims, further, that it is extremely high in water resistance and also practically perfect in plasticity.

TRADE CATALOG

Crushing and Screening — Portable gyratory crushing and screening plants are described in a sixteen-page pamphlet put out by the Austin Manufacturing Co., 400 North Michigan Ave., Chicago, Ill.

Trucks—In an eight-page catalog the Four Wheel Drive Auto Co., Clintonville, Wis., describes its F. W. D. winch equipment and the uses to which it may be put.

Water Softening—"Zero, or One and One-Half. Which?" is the title of a 12-page book describing the Graver Hot Process water softener, which has been issued by the Graver Corporation. The process is contrasted with the Zeolite process in a manner claimed to be free from bias since (it is stated) the company makes both types of water softeners.

Car Puller—The Gifford-Wood Co.'s G-W electric capstan car puller is described in a leaflet just issued. The company is located at Hudson, N. Y.

Crushers—Bulletin 1005 of the Pennsylvania Crusher Co., Stephen Girard Bldg., Philadelphia, covers the company's line of heavy-duty Pennsylvania "steelbuilt" hammer mills, used for reduction of limestone, cement rock, gypsum, shales and similar materials. A patented automatic tramp-iron separator is featured.

Slusher Hoist—The Sullivan Machinery Co. describes its Turbinair hoist, of the double-drum HDA type, in Bulletin 76-D, just issued. This hoist weighs 555 lb. or about 85 lb. per hp., is 29 in. long by 15 in. wide and stands 19 in. high. Bulletin 76-C describes the single-drum type HA Turbinair hoist. In these catalogs considerable new matter has been added to earlier editions.

"Bucyrus Placer Dredge Machinery" is the title of a catalog on dredge operations, recently published by the Bucyrus Company. It marks the development of dredging machinery from its beginning and the position occupied by the company in the mining of alluvial deposits of gold, platinum and tin in the greatest alluvial mining districts of the world. The catalogue includes a discussion of the requisites of a successful alluvial mining project; the choice of the dredge, standard sizes and capacities, the design of the various units and the information required for preliminary quotations. It will be sent to those interested by addressing the Bucyrus Company, South Milwaukee, Wis.